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Table 17: The relative impact summed over three management scenarios (A) the maximum stacking scenario where all three managements are combined compared to the baseline (B), the absolute difference between sum and stack impacts (C), the difference as a percentage of the summed impacts (D). Mean calculated without ladybirds and inverting aphid impacts. Results are based on combined DK + DE scenarios since these were the only ones where all individual scenarios were run.	138

Results of integrative analyses- European scale analysis of impacts of EcoStack innovations and suggested management strategies (Northern/Central Europe)

1 INTRODUCTION

This report draws together the work done under WP8 of the EcoStack project to culminate in the development of integrative scenarios for evaluating ecostacking strategies in six countries in Europe. The main components of this work are the generation of landscape models and scenarios for each of the countries involved, the development or adaptation of animal models, and the implementation of the scenario runs and subsequent analysis.

1.1 Background

In landscapes dominated by agriculture many species are pushed to the edge of survival hanging on in the margins of agricultural land. Many of these species provide useful ecosystem services such as cultural, pest control or pollination and it is widely accepted, therefore, that species should be maintained within the farmed landscape. There are multiple measures that can be implemented to support particular species, however what combination of measures most efficiently provide the greatest improvement on the numbers of species combined is unclear. Each individual management has a complex impact on each species and combined managements may not have a simple additive effect. Therefore, the impact of different managements and their combination need to be assessed to determine which measures farmers should be encouraged to make.

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Such an assessment is a complex issue. There are many debates regarding the effectiveness of individual measures aimed at improving biodiversity or ecosystem services. Not only is it the case that one size does not fit all in terms of species, but equally the same measure may not work equally well in different places or at different times. This context dependency is a major complicating factor in determining the best policy options. These problems occur even when the goal is clear, e.g. promoting a population of an individual species, but when the management goal is broader or vaguely defined issues are exacerbated. For example, a general statement about supporting biodiversity or ecosystem services will be open to broad and diverse interpretation. Hence, a clear management goal is needed as a first step towards defining a working strategy for employing ecostacking or even individual management measures.

The approach taken in EcoStack WP5 is to develop detailed simulations representing arable landscapes in countries across Europe, and to use these as the basis for evaluating the impact of individual and combined measures on a range of beneficial species. This approach allows us to determine which types of measures are generally beneficial, and to what extent we might need to tailor strategies differently for different countries. In addition, we needed to develop a way to allow different priorities to be included in the scenario planning. We aimed to use the Animal Landscape and Man Simulation System (ALMaSS) to run baselines and scenarios for multiple species and multiple landscapes across six countries in northern and central Europe. By assessing the impact of each scenario individually, we can then propose combinations of scenarios in a multi-criteria analysis, stacked to give an optimised scenario that maximises positive outcomes for beneficial farmland species or biodiversity more generally with minimum loss to farm productivity/area.

At the start of the project ALMaSS already existed, as did models for a number of species. However, at that point most models were only developed for use in Denmark, and landscape and agricultural models for other countries were partially developed only for Poland and The Netherlands. To realise the ecostacking ambition new species models needed to be developed as well as detailed models for each country to simulate landscape, weather and farming. This was planned as part of the project, but during this development it became clear that there were other, unexpected, challenges that materialised. Chief among these were the need to develop dynamically linked simulations (for ladybirds and aphids), and the need to both increase computational efficiency and utilise High Performance Computing facilities to be able to run the scenarios developed.

Drawing together all the methods has provided the basis for a first demonstration of how these detailed, and computationally advanced, systems simulations can be used to support policy and strategy for farmed landscapes. It is only a beginning, providing many new avenues to explore from this point onwards.

1.2 Aims and objectives

The aims of this study were to demonstrate how ALMaSS can be used to assess the impacts of individual and stacked scenarios across multiple landscapes (ten per country) and across multiple countries (Denmark, Germany, Netherlands, Poland, France, and Finland) and towards different agricultural landscape management goals. We ran eight species agent-based model (red mason bee (*Osmia bicornis*), ground beetle (*Bembidion lampros*), a spider (*Erigone atra*), another spider (*Oedothroax fuscus*), Seven-spot ladybird (*Coccinella septempunctata*), Eurasian skylark (*Alauda arvensis*), European hare (*Lepus europaeus*) and field vole (*Microtus agrestis*) and four stage structured population models for four aphid species (*Aphis fabae*, *Acyrtosiphon pisum*, *Myzus persicae* and *Sitobion avenae*) as representatives of three potential goals (pollination, pest control and vertebrate biodiversity) for increasing species abundance and decreasing crop pests. With this in mind, we ran baseline scenarios representative of the current management and seven scenario types with multiple different intensities totalling 20 individual scenarios. Having completed the thousands of combinations of scenarios, species, landscapes, countries, and repetitions, we then analysed the impact of each scenario in each country on each species and performed multi-criteria analysis, determining which scenarios to stack together (EcoStack), ran these stacks and analysed the impact of the ecostacking scenarios.

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2 METHODS

This study uses the ALMaSS set of models. ALMaSS stands for The Animal, Landscape and Man Simulation System and is an open-source project hosted on GitLab (<https://gitlab.com/ALMaSS/>) (Topping et al., 2010). ALMaSS encompasses many different components as it integrates models of selected species with detailed descriptions of an environment (landscape) from which modelled individuals obtain information necessary to simulate their behaviour. A simulated landscape uses real landscape data on land cover and farm location and management. Weather data drives models of vegetation biomass, nectar and pollen production and farming actions. Farming models cycle through rotations and farming actions. On top of these, species models have been built either as agent-based models or what we are terming sub-population models (a form of spatial stage-structured population model). These species models run through the model time with the individuals of different life stages interacting with the simulated landscape. The individuals gather food or choose their location based on the characteristics of each parcel of land. Farm events within a parcel disrupt or cause mortality for the individuals. It is possible to run simulations on a given landscape with farming management as it is (this is what we call a 'baseline' scenario), but also run different scenarios with modified landscape structure or farming management. In this section we outline how simulated landscapes were selected and generated across Europe. We explain how the farming management was modelled to reflect real crop rotations and crop cultivation in different European countries. We also shortly present species models used for simulation and describe different scenarios being explored, as well as simulation set-up and outputs. Finally, we lay out how we propose to analyse the results across species, landscapes, and scenarios.

2.1 Landscape Generation Overview

2.1.1 Landscape representation in ALMaSS

In ALMaSS, landscapes are modelled using a detailed, spatio-temporal representation which provides a realistic environment for agent-based simulations of the focal species.

2.1.1.1 *Spatial landscape heterogeneity*

In the ALMaSS representation spatial landscape heterogeneity is described by a detailed raster land cover map with complete coverage and spatial resolution of one metre. Each unit in the raster land cover map is classified in accordance with its landscape element type (e.g., natural or permanent grassland, field in rotation, built-up area), including detailed structures important for the species under consideration, such as hedgerows or field margins. To better represent farming areas, field boundaries are also mapped, with each field being allocated to a given farm unit (i.e., group of fields managed by the same farmer) via external text files. Farm units are classified into different types, e.g., cattle, pig, or arable farms, based on structure of crops grown and animals present in the farm. This structure allows the incorporation of information on farm management to the description of spatial heterogeneity at a given point of time (Topping et al., 2016, Topping et al., 2003b).

2.1.1.2 *Temporal landscape heterogeneity*

Temporal landscape heterogeneity in the ALMaSS representation includes both crop management throughout a year, described through individually tailored management plans for each crop, and the cropping system understood as a multi-year crop rotation. Associated vegetation growth models for all modelled vegetation types and crops supply vegetation height, green and total daily biomass. In addition, pollen and nectar production is modelled for various natural and man-made habitats (e.g., road verges, field margins), based on information on production from individual plant species and composition of plants within different habitats. Both vegetation growth models and floral resource models are driven by temperature. Daily weather conditions (e.g., air and soil temperature, wind speed, sum of precipitation) can also impact farming management (as some farming operations like tillage or pesticide application, are dependent on weather conditions), and distribution and persistence of pesticide loads in the landscape (distribution may be modified by wind, and persistence by temperature).

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The generation of the ALMaSS landscape models follows the methodology described in detail in Topping et al. (2016), and it is based on previous experiences with model landscape generation for Denmark. The whole process can be divided into the following sub-tasks: (i) spatial (landscape) and non-spatial data collection & quality check, (ii) ALMaSS landscape map generation (spatial component), (iii) incorporation of crop management & vegetation growth (dynamic component).

2.1.2 Major categories of data needed for the generation of the ALMaSS landscape model

The generation of the ALMaSS landscape model is based on information from different data sources of sufficiently high resolution and quality (Figure 1).

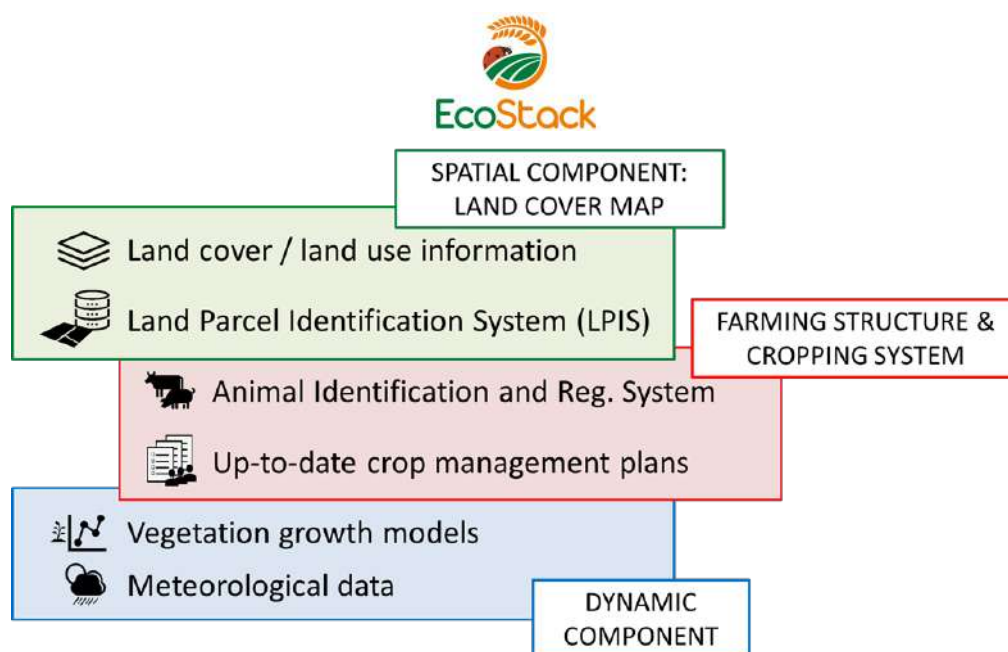


Figure 1 Main types of input data needed for generation of the ALMaSS landscape model.

The necessary categories of data follow below.

2.1.2.1 Land use/land cover

Land use/land cover information including the map layers presenting natural and/or semi-natural landscape elements (e.g., rivers or streams, lakes, bare sand or rock, steep slopes); natural or semi-natural vegetation (e.g., hedgerows, open vegetation types, forest, isolated trees); infrastructure (e.g., roads, buildings, or industry); and protected areas.

Such information usually comes from different data sources, but in most cases the topographic object databases with level of details corresponding with topographic maps at the scale of 1:5000 – 1:25000 are the most important source of land cover/land use information needed for the ALMaSS landscape model generation.

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2.1.2.2 Agriculture

Agriculture (e.g., field boundaries linked to farm management) - Under the Common Agricultural Policy (CAP), if farmers want to apply for the EU subsidies, they are obligated to report for each individual reference parcel the crop/crops they grow (with information of area of each crop grown) and the number of livestock they own. The Land-Parcel Identification System (LPIS) has been developed in each of the EU countries to support CAP and it stores geographic information on 'reference parcels'. Different types of 'reference parcels' can be used including agricultural parcels, farmer blocks, physical blocks, and cadastral parcels, depending on the country. The data on 'reference parcels' together with agricultural register (related information on type of crops grown and their coverage) needs to be merged with the land use/land cover information from (i).

Since the parcel layer is based on subsidy payments from the EU, and it is mandatory for farmers claiming subsidy to make the delineation/definition of the parcel(s), this layer has various level of detail depending on the country/region. On those landscape windows where the information regarding the field parcels is too scarce or incomplete, one strategy is to use fine spatial resolution image data (e.g., Sentinel-2 time series data, orthophoto) and pixel and object-based image processing and analysis methods to determine the field boundaries and the crop types.

2.1.2.3 Farm animal data

Farm animal data (Animal Identification and Reg. System) - together with the register of crops these data are used to classify farm units into general farm types.

2.1.2.4 Soil type

Soil type information for vegetated landscape elements – as the ALMaSS landscape simulator modifies the actual production on each field based on the dominant soil type. Soil data at the EU level were obtained from the European Soil Database provided by the Joint Research Centre.

2.1.2.5 Weather data

Weather data – including historical data on mean daily temperatures, wind speed and daily sum of precipitation for at least 10 years. At the EU level these data can be obtained from the European Climate Assessment & Dataset project.

2.1.2.6 Crop management plans

Up-to-date crop management plans – describing time windows and probabilities of occurrence of all farming operations including soil cultivation practices, as well as fertilizer and pesticide applications.

2.1.2.7 Vegetation growth models

Vegetation growth models if not already in ALMaSS. Inside the model landscape, all vegetation types and crops have their own seasonal growth models supplying vegetation height, green and total, biomass.

2.1.3 Overview of the processing steps

2.1.3.1 Generation of the ALMaSS landscape map (spatial component)

Generation of the ALMaSS landscape map (spatial component) was done by combining individual layers of land use/land cover information together with information on agricultural fields into a single raster landscape map in a step-by-step process. As layers from different data sources were used, this resulted in inconsistencies related to spatial alignment of features (i.e., overlaps or gaps between features). In addition, some objects were represented as points or lines (dimensionalities of 0 and 1) and had first to be pre-processed in order to change them into two-dimensional ones. However, this process increased the number of inconsistencies in the combined map even more, so a special semi-automated step-by-step procedure was applied to be able to obtain a landscape raster map with no gaps in information and with removal of sliver polygons.

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The overall process to generate the ALMaSS landscape map consisted of the following general steps (although some specific processing steps were needed in the case of each country due to specific national/regional data):

- (1) Clipping the input layers to the study area extent;
- (2) Converting the input vector data to raster format (with spatial resolution of 1 m), object class by object class;
- (3) Combining individual layers into thematic maps (e.g., transportation theme, built-up theme);
- (4) Stacking of thematic maps to generate a raw landscape map (Figure 2);
- (5) Reclassification of large 'background' polygons, and removing of inconsistencies in the landscape raw map (multi-stage process);
- (6) Reclassification and regionalization of the resulting landscape map. The landscape map contains more details than are used in ALMaSS. Therefore, to be consistent with landscape element types used in ALMaSS we used simple reclassification based on a text file (separate for each analysed country). All features in the ALMaSS landscape map, consisting both of single and multiple raster cells, have a unique value that is common to all cells within the feature. This was achieved by regionalizing the raster before exporting the map as a final ASCII file.
- (7) Visual inspection of the produced land use / land cover maps against the satellite images (e.g., via Google Earth platform) and (if necessary) manual modification to best reflect the real situation;
- (8) Exporting results;
- (9) Generating input files for ALMaSS.

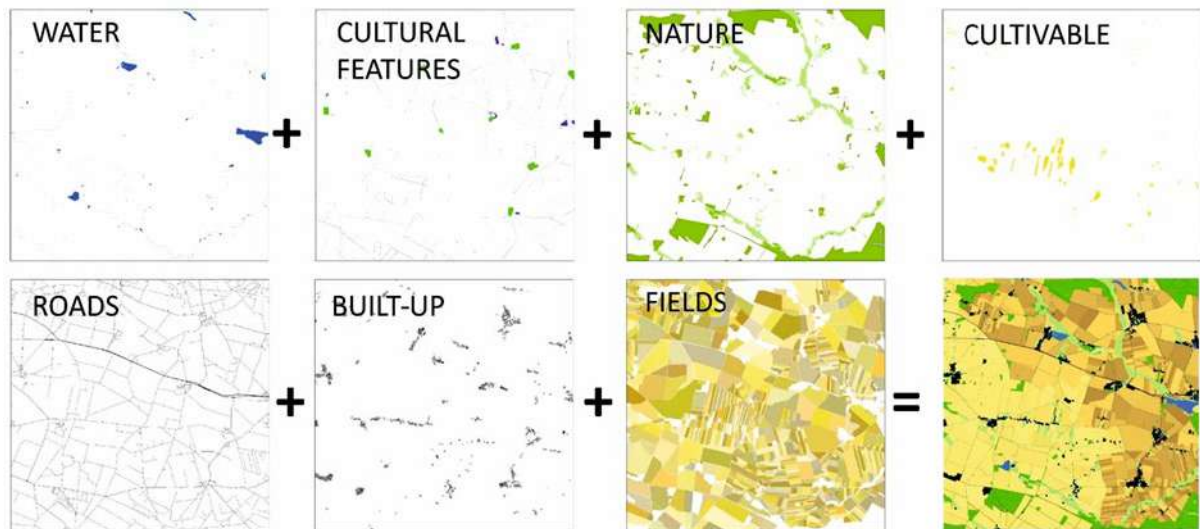


Figure 2 Stacking of GIS layers.

2.1.3.2 Farming structure and cropping system

In ALMaSS, crop management is applied at the farm level, therefore individual agricultural parcels (fields) need to be grouped into farm units of different types (e.g., conventional or organic cattle, pig or arable farms). Farm classifications were generated for each country/region separately based on LPIS and farm animal data.

Based on proportions of crops cultivated by farms of different types, crop rotation schemes can be generated for each farm type individually. Only crops with more than 1% share of the area of a farm type are considered. In such a case it is assumed that the rotation could be represented by 100 crops (1 crop for each 1%). The order of crops follows typical agronomic practices and issues such as late harvest leading to impossible sowing conditions are controlled by the built-in ALMaSS farm code. The result is a pattern of changing crops on a field that matches the overall crop distribution pattern for that farm type precisely over 100 seasons. If a specific crop, e.g., maize for silage, occurs 13 times out of 100 in the rotation, it will on average occur on 13% of all fields covered by that rotation at any point in time. It is also possible to use pre-defined crop rotation schemes. The consequence of this is that for each farm type for each country there is a *.rot file which has 100 entries, each one representing 1% crop by area, and ordered in an agronomically sensible sequence. Each entry represents a code for a given crop e.g. DKWinterWheat represents Danish conventional winter wheat, DKWinterWheat_CC the same, but followed by a catch crop. A part of an example crop rotation file is shown in Table 1.

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Table 1 Excerpt from a Danish arable farm rotation file. The top number indicates the number of entries, typically 100, each entry below is a text code referring to a particular crop management file.

100
DKWinterWheat_CC
DKSpringBarley
DKWinterWheat
DKWinterBarley
DKWinterWheat
DKSpringBarleyCloverGrass
DKCloverGrassGrazed1
DKCloverGrassGrazed3
DKSpringBarley
DKWinterBarley
DKWinterWheat_CC
DKSpringBarley
DKWinterRye_CC
DKSpringOats_CC
DKSpringBarley
DKWinterFodderGrass
DKWinterWheat_CC
DKSpringOats_CC
DKSpringBarley
DKWinterRape
DKWinterWheat_CC
DKSeedGrassFescue_Spring
DKWinterBarley
DKWinterWheat_CC

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2.1.3.3 Incorporation of crop management & vegetation growth (dynamic component)

Inside the model landscape, all vegetation types and crops have their own seasonal growth models supplying vegetation height, green and total biomass. The result is a dynamic landscape with all vegetation growing in response to the weather. Crops and other vegetation also respond to management. Crops will grow from sowing and respond to management events such as harvest and cutting, which are programmed into the ALMaSS according to crop management plans provided by farmer advisors or other experts from each analysed country (Figure 3). Non-crop vegetation can also be managed, e.g., roadside verges are mown during summer in the model.

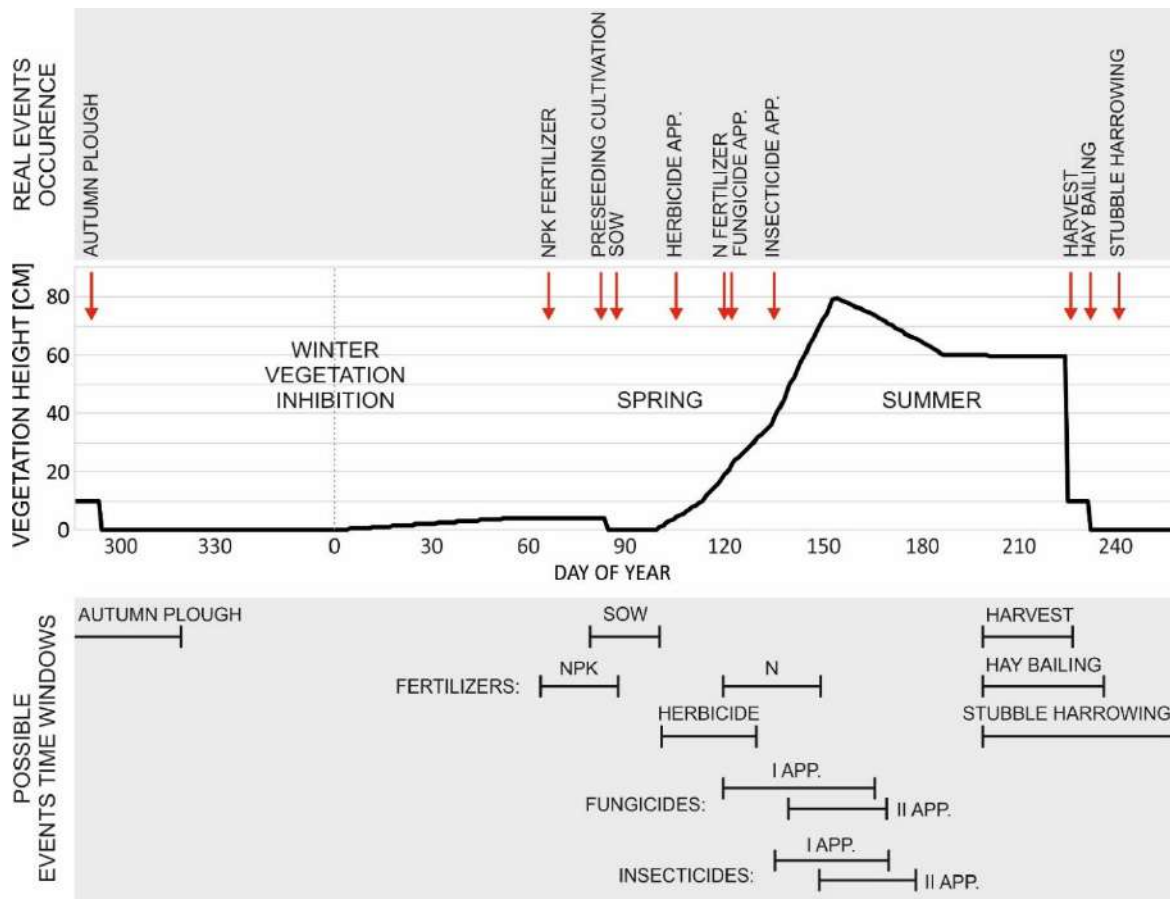


Figure 3 Crop management for spring barley on a field belonging to an arable farm in Poland.

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2.1.3.4 Automatization

All handling and analysis of spatial data was done using Python 2.7 (Van Rossum and Drake, 1995) and the Python library ArcPy to access ArcGIS features (Esri, 2020), or directly in ArcGIS 10.x (migration to open-source software is underway). The entire process of producing landscape models for ALMaSS has been programmed in Python scripts with Pandas library (McKinney and Others, 2010), separately for each country. As all procedures for generating landscape models for ALMaSS are automated or semi-automated, any landscape in each of the analysed countries/regions can be 'captured' and used for simulation (Figure 4).

2.1.3.5 Structure of landscape input files in ALMaSS

The input files describing floral resource models are linked to landscape input files in ALMaSS. There are three input files describing landscape model in ALMaSS:

- (1) A raster map of typically 10x10 km with a spatial resolution of 1m² (in .lsb format), in which each pixel has a value indicating a unique ID of a polygon grouping pixels that form a homogenous patch of the same land use / land cover type (e.g., deciduous forest patch or arable field patch);
- (2) A polygon reference file, which is a text file listing unique IDs of all polygons in the landscape, with information on their landscape element type, the number of cells belonging to each polygon (i.e., polygon area), a reference number to a farm owner/ farm holding (in the case of all polygon types under agricultural management), the soil type, elevation and aspect of each polygon (optional), and an indication of habitat type (for all vegetated polygon types);
- (3) A farm reference file, which is a text file associating farm reference numbers with farm types, which are then linked to farm management actions within ALMaSS.

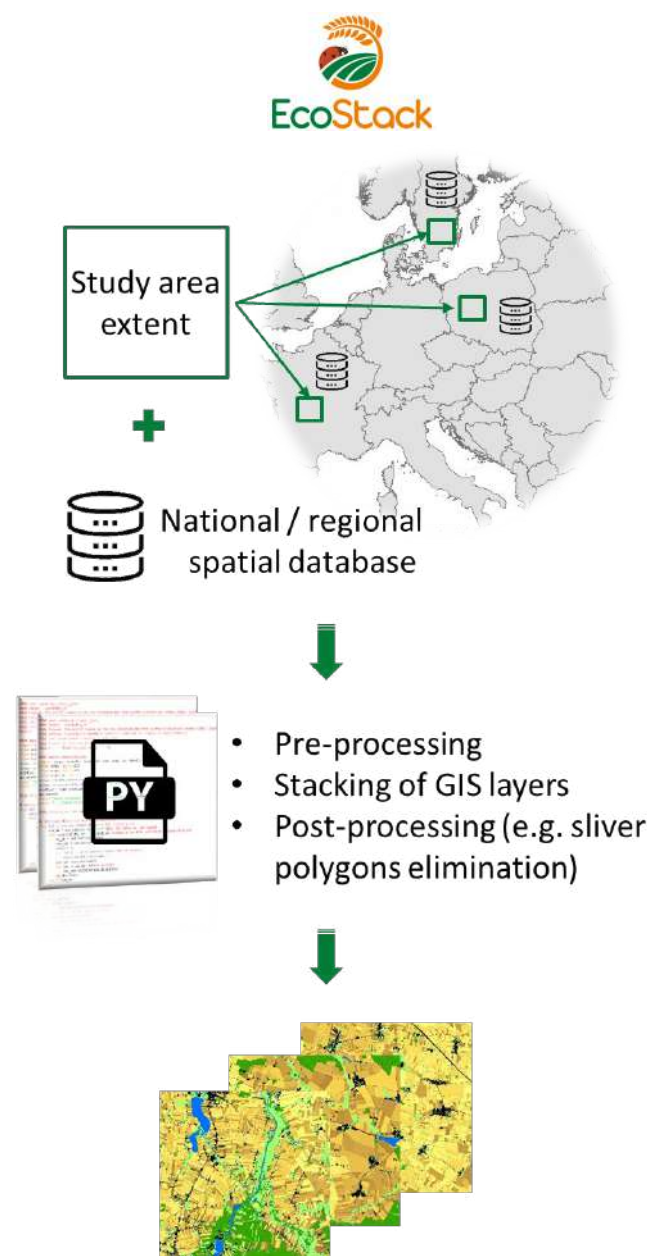


Figure 4 (Semi-) automated processing procedure.

2.2 Study Areas and Their Characteristics

Six countries were selected as representative for species modelling in both the H2020 EcoStack and PoshBee (GA 773921) projects (due to the formal collaboration between these two projects). These are: Poland and Germany (Lower Saxony and Brandenburg regions) in the northern continental pedoclimatic zone, Denmark and the Netherlands in the Atlantic pedoclimatic zone, France (Auvergne-Rhône-Alpes region) in the southern continental pedoclimatic zone, and Finland in the boreal pedoclimatic zone (Figure 5).

ALMaSS landscape models for Poland, Finland, and France have been developed within the EcoStack project. Unfortunately, due to limited access to LPIS data on agricultural parcels, only one French region could be modelled - the Auvergne-Rhône-Alpes region. The ALMaSS landscape model for Denmark already existed but was updated within the EcoStack project. The ALMaSS landscape model for the Netherlands was developed within the project “Development and application of a methodology for assessing the interaction between pesticides and landscape structure” funded by the PBL Netherlands Environmental Assessment Agency. The ALMaSS landscape model for Germany was developed within the ELONTA project (“Evaluating the impact of landscape structure and source-sink dynamics on non-target arthropod pesticide risk assessments in Germany”), funded by the German Environmental Agency (UBA). Access to LPIS data on agricultural parcels was

also problematic in Germany, limiting the generation of the so that the ALMaSS landscape model to only two German regions: Lower Saxony and Brandenburg.

The protocols developed allow the automatic extraction of landscape data for landscape windows of a given size (typically 10 x 10 km) and the generation of the necessary ALMaSS input files for the simulation. Automatic extraction and compilation of data for simulation means that scaling can be applied by simulating multiple areas for a country using batch file processing on mainframe computers/clusters.

We are using a GitLab repository to store and distribute the open data products of this task (<https://gitlab.com/ALMaSS/almassauxillary> in a folder called 'landscape_generation'). These products include all the scripts that allow the (semi-)automated generation of the ALMaSS landscape models and other important input data.

As we wanted to focus on agricultural landscapes dominated by arable land (i.e., where pesticide applications are a common threat for beneficial organisms), ten study areas of 10x10 km with at least 60% of arable land were further selected for modelling in each of these countries (Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11) in such a way as to represent a gradient in the number of fields and average field size (see Figure 12 and Figure 13 for landscape characteristics of selected study areas). In Finland and France, it was not possible to find ten study areas of 10x10 km with at least 60% of arable land, so this threshold was lowered to 50% and 55%, respectively (see Figure 12).

Selected study areas differed considerably regarding the farmland structure. The most homogenous farmland structure with a relatively large-scale farming and a predominance of large fields (mean field size from 12 to 16 ha) can be found in the study areas from the Brandenburg region in Germany. Medium and large fields are also predominating in study areas located in the Netherlands (mean field size from 4 to 10 ha), and Denmark (mean field size from 6 to 10 ha), however in the Netherlands coverage of pastures and linear grassy elements (e.g., road verges, field margins) within the analysed study areas is much higher than in Denmark. Study areas located in the Lower Saxony Region in Germany, in the Auvergne-Rhône-Alpes region in France and in Finland, the farmland is rather dominated by small and medium fields (mean field sizes from 3 to 5 ha in Germany and France, and from 2 to 4 ha in Finland). The biggest variation in farmland structure between study areas located in the same country is found in Poland (mean field size from 1 to 8 ha), where both study areas of rather homogenous farmland dominated by large farming companies and those of extremely heterogenous farmland (mean field size of 1 ha, and mean number of fields of ~ 7100) can be found.

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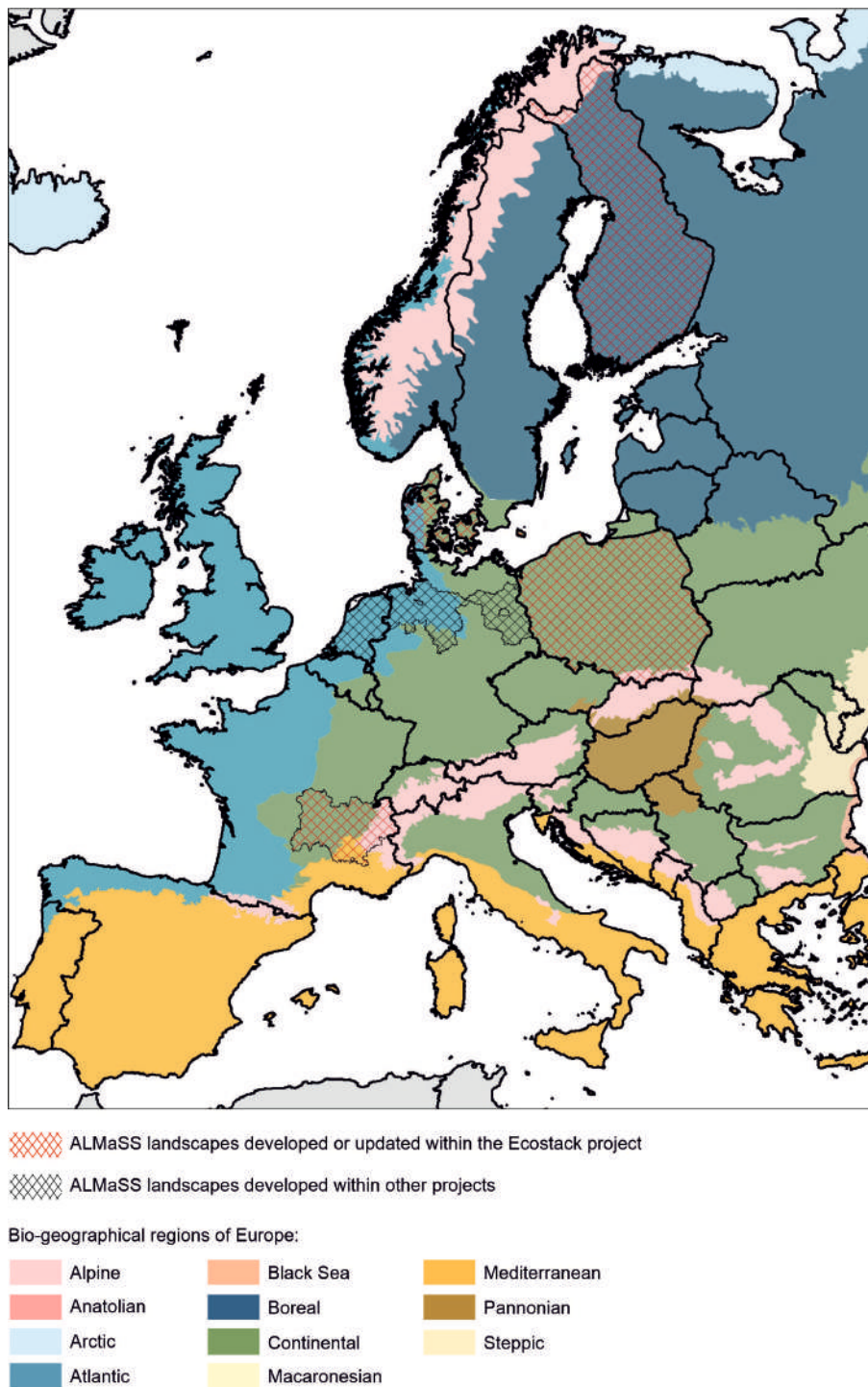


Figure 5 Countries (or regions within countries) located in various biogeographical regions of Europe (Denmark, Finland, Auvergne-Rhône-Alpes region in France, Lower Saxony and Brandenburg regions in Germany, Poland, and the Netherlands) selected for analyses in the EcoStack project. Within the EcoStack project, ALMaSS landscape models were developed for Poland, Finland, and France, and fully updated for Denmark. ALMaSS landscape models for other countries selected for analyses were developed within different European and national project (see details in the text). Source of the map of biogeographical regions of Europe: European Environment Agency (EEA).

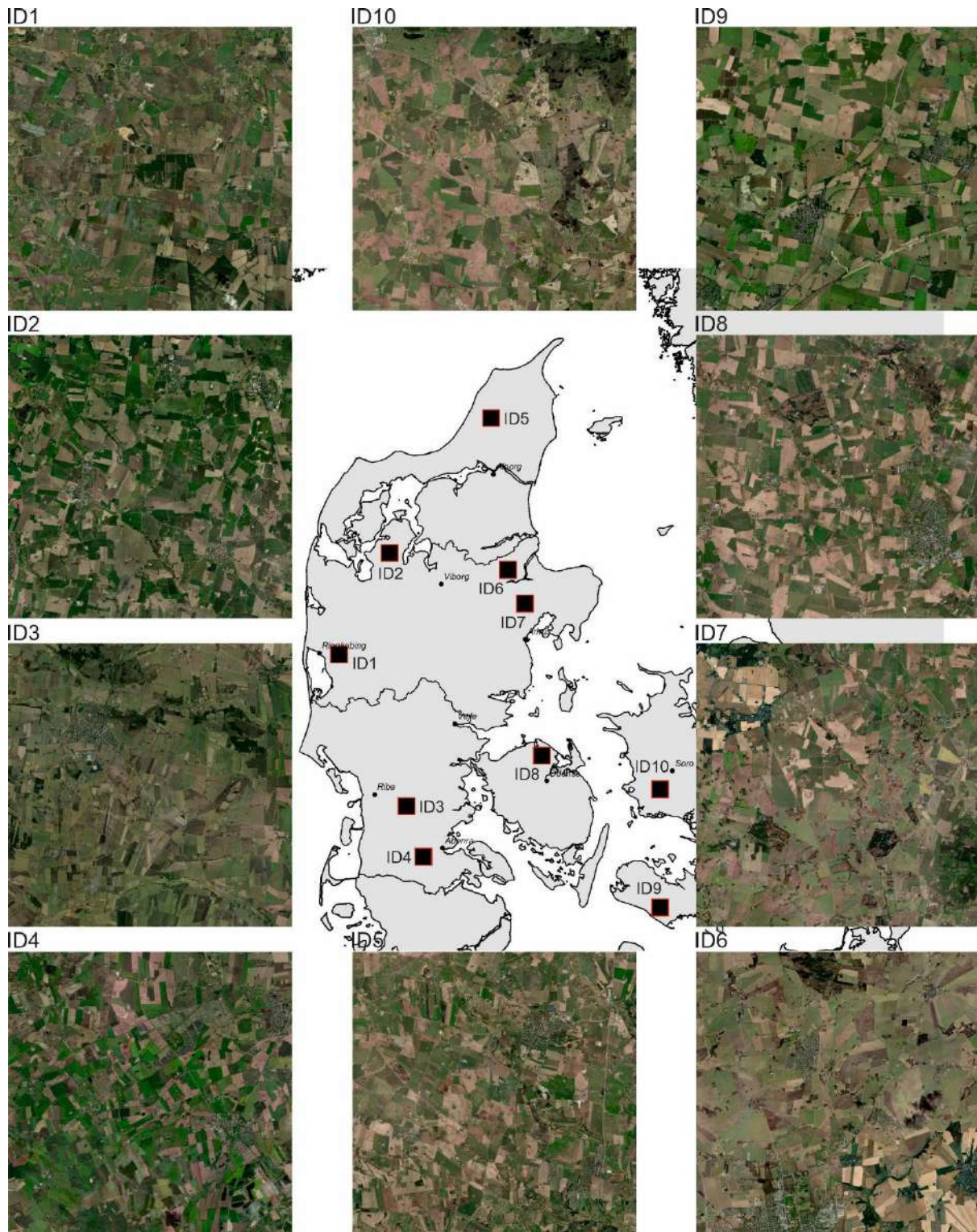


Figure 6 Map showing the 10 study areas and their locations for the set of Danish landscapes.

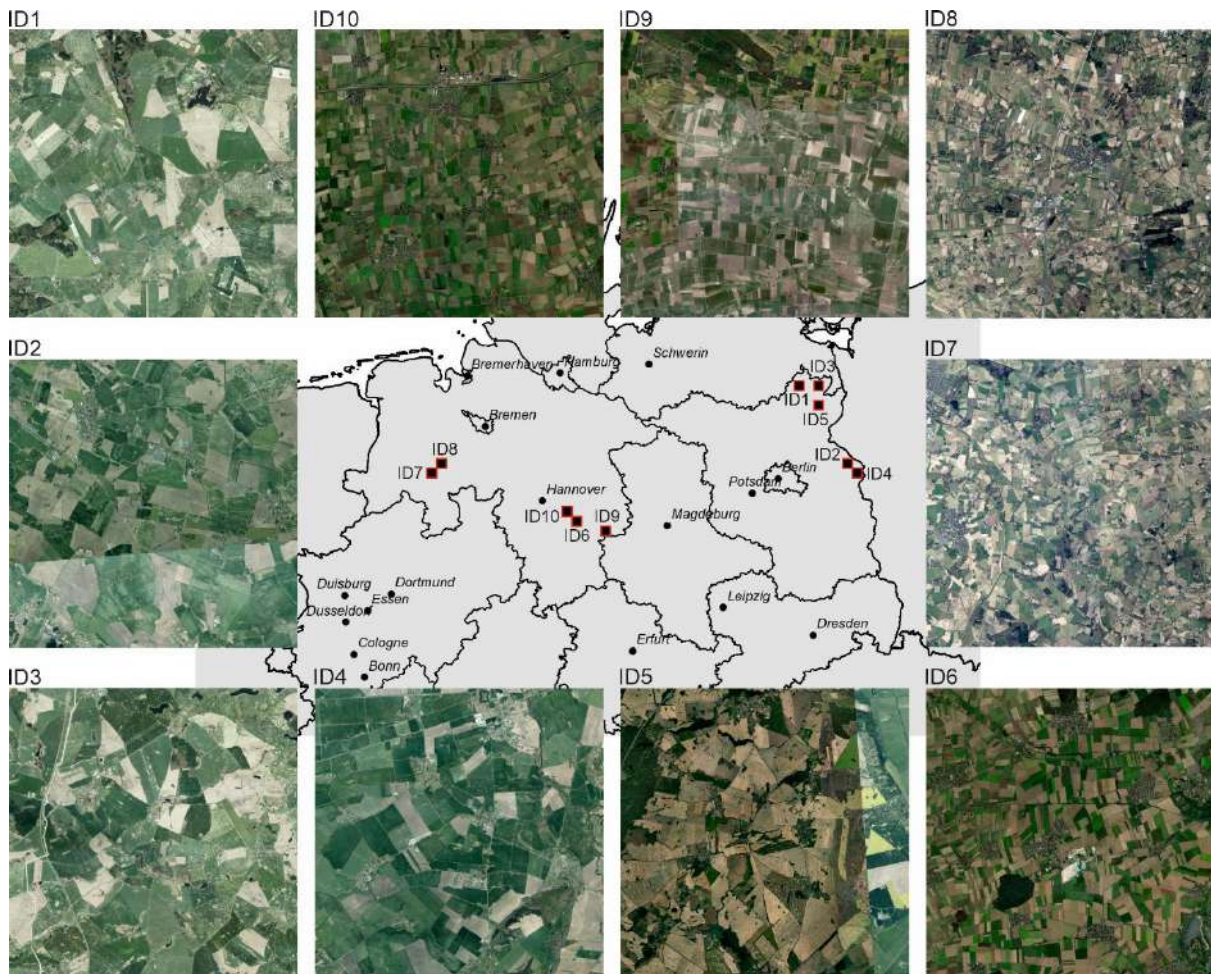


Figure 7 Map showing the 10 study areas and their locations for the set of German landscapes in two regions of Brandenburg and Lower Saxony.

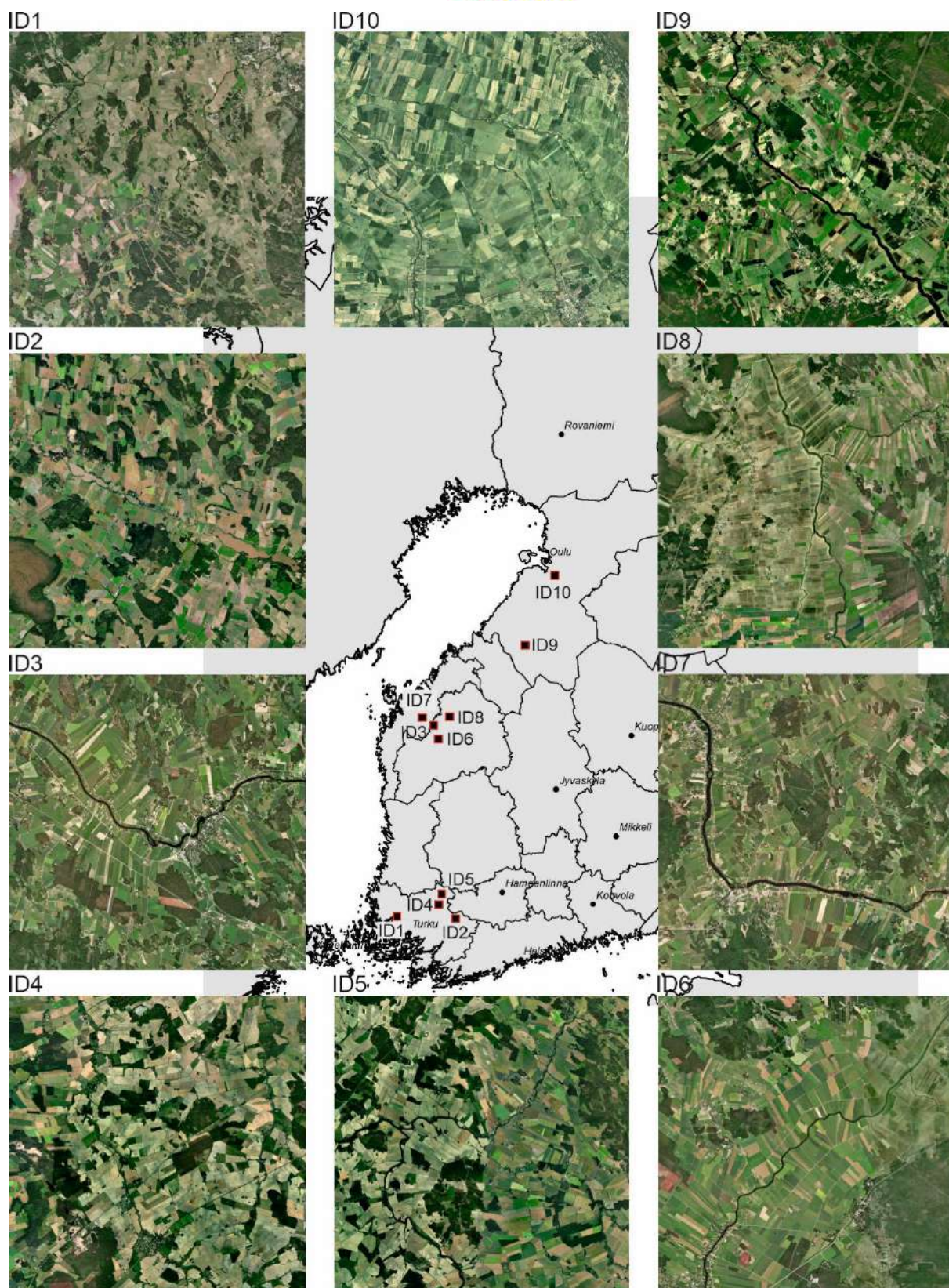


Figure 8 Map showing the 10 study areas and their locations for the set of Finnish landscapes.

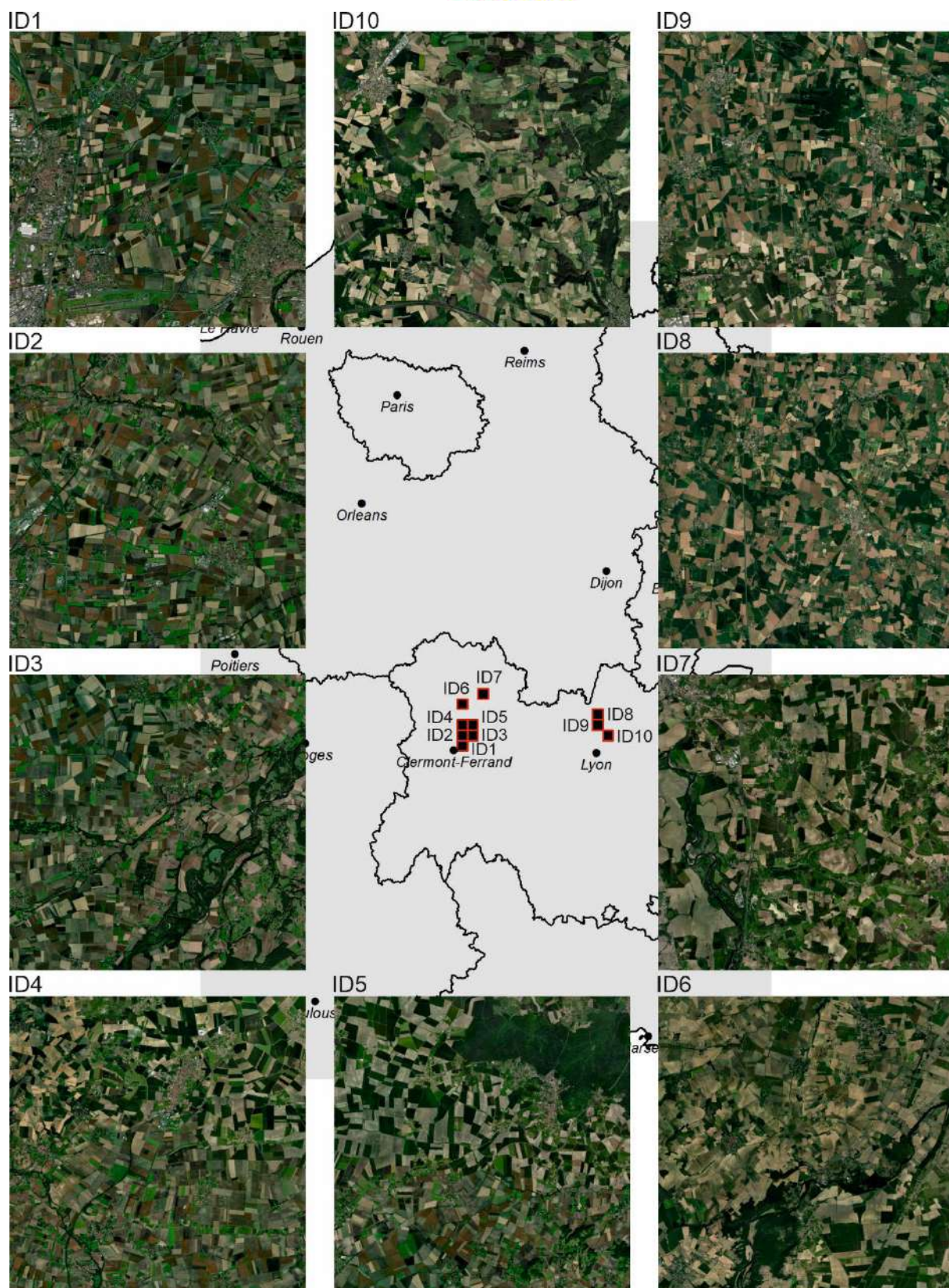


Figure 9 Map showing the 10 study areas and their locations for the set of French landscapes in the Auvergne-Rhône-Alpes region.

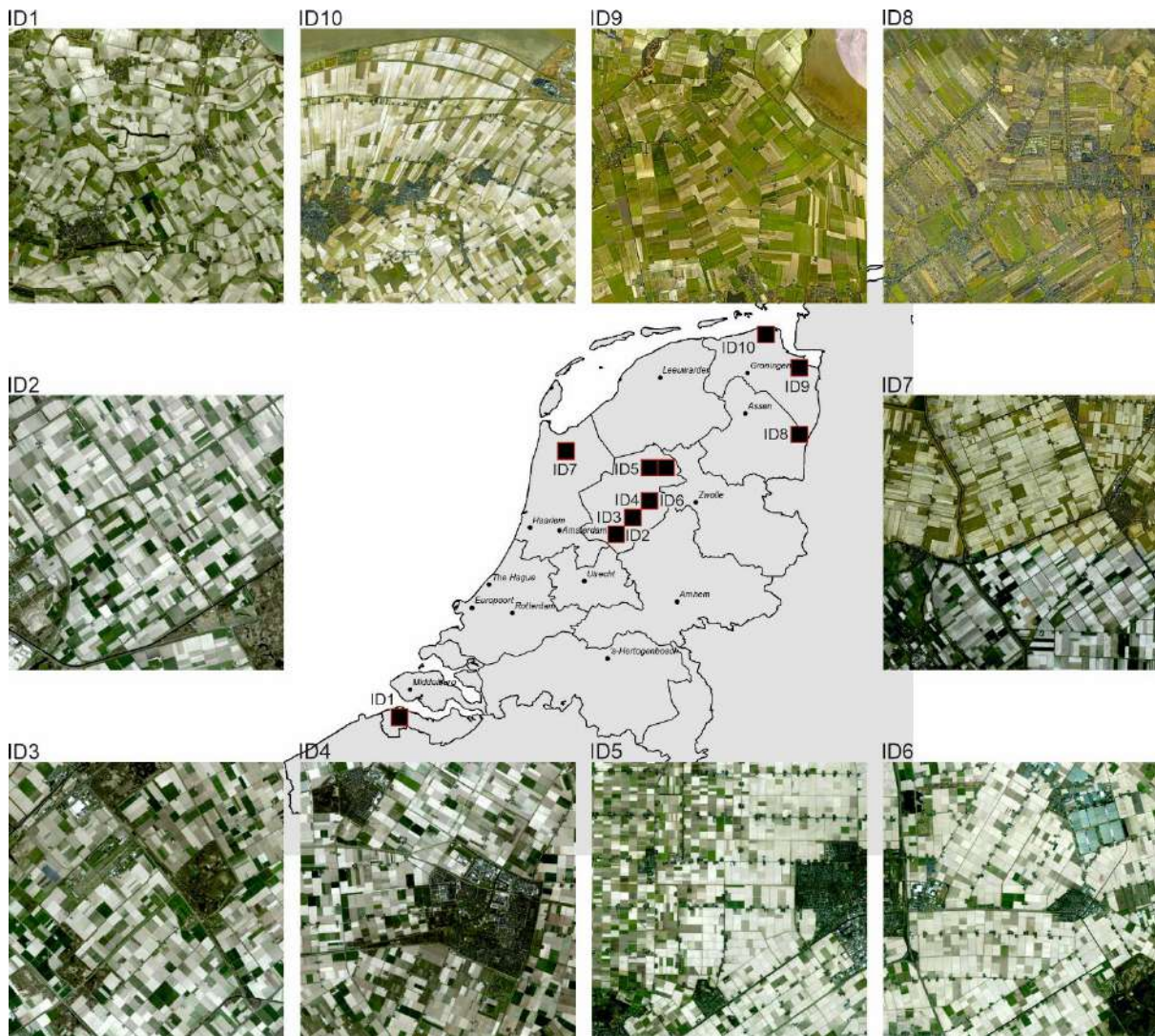


Figure 10 Map showing the 10 study areas and their locations for the set of Dutch landscapes.

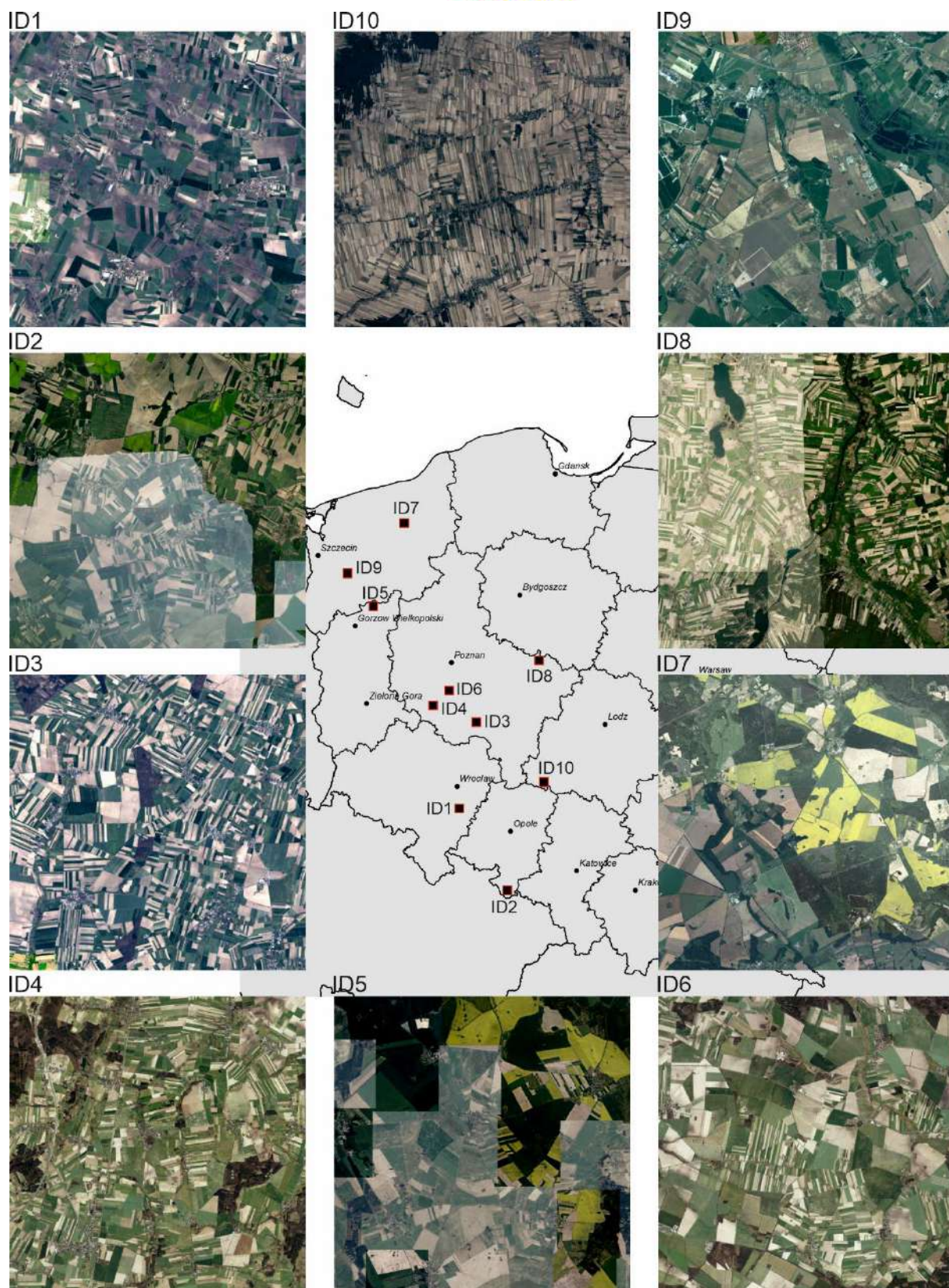


Figure 11 Map showing the 10 study areas and their locations for the set of Polish landscapes.



Figure 12 Landscape composition in the analysed study areas (only vegetated land cover / land use classes included) in (A) Germany, (B) Denmark, (C) Finland, (D) France, (E) the Netherlands, and (F) Poland.

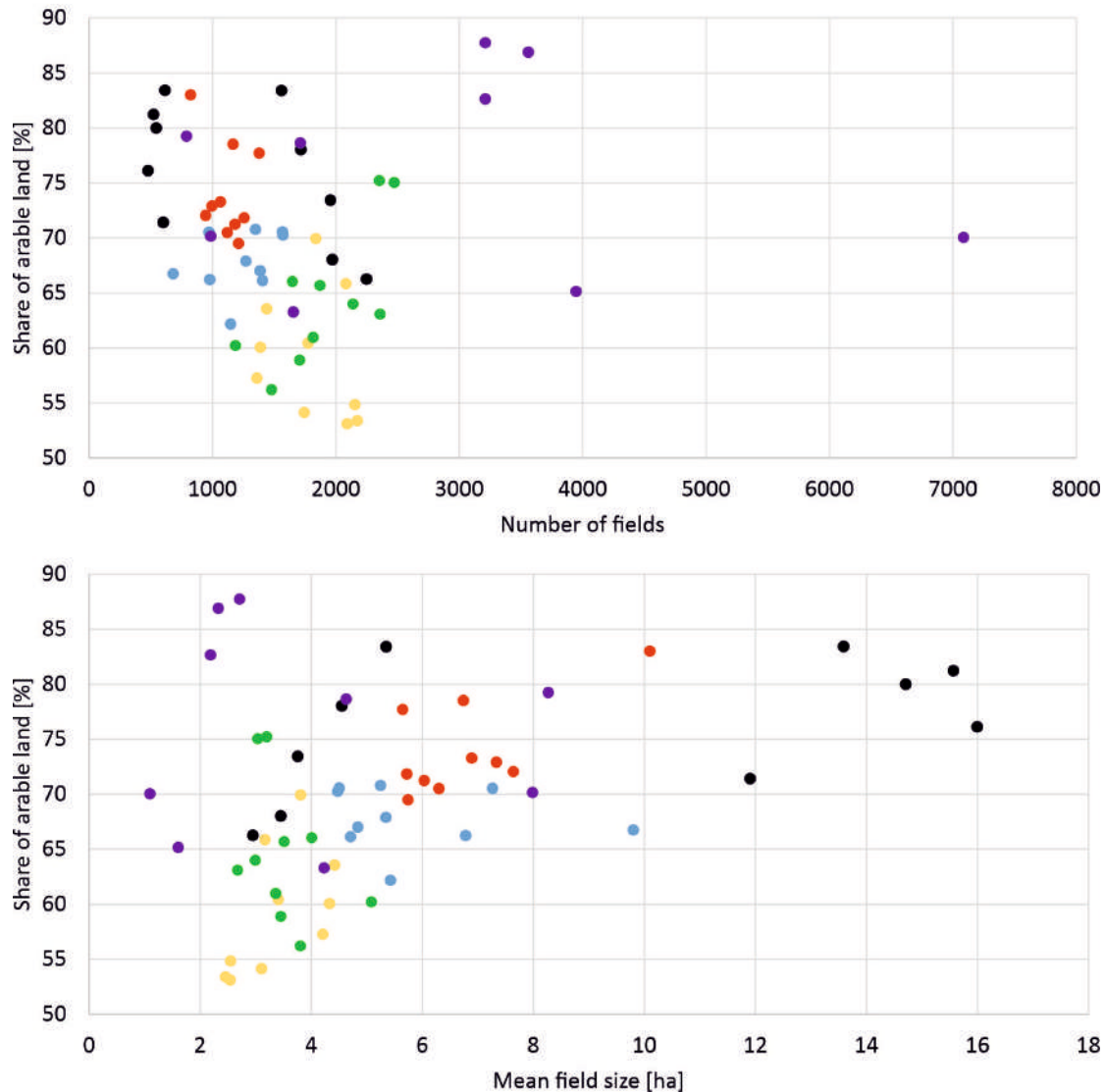


Figure 13 Basic characteristics of the farmland area in the analysed study areas.

2.3 Floral resource models

Floral resource models describe pollen, nectar, and sugar production levels and their changes throughout the year. They are incorporated in the ALMaSS landscape model representation of landscape elements/habitat units and crops important to bees across Europe. The floral resource models are of crucial importance for pollinator models being developed under the ALMaSS framework. They have been developed within the European Union's Horizon 2020 research and innovation program (B-GOOD project; grant agreement no. 817622). Documentation and all the important input files for floral resource models are stored in an open GitLab repository (https://gitlab.com/ALMaSS/floral_resource_models).

Floral resource models integrate data on the composition of 'bee-friendly' (i.e., attractive to bees) plants within the main landscape elements/habitat units important for bees across Europe with data on floral resource production (amount of pollen, nectar and sugar produced per flower unit), flowering abundance (i.e., flowering density per unit area), and flowering phenology of individual plants (Figure 14). As the floral resource models need to be dynamic across the EU, the floral phenology of selected 'bee-friendly' species is analysed in relation to growing degree-days. This allows us to first generate the floral resource models for individual plants, and then to upscale them to the habitat and finally to the landscape level (Figure 15). Therefore, pollinators

modelled in ALMaSS can access information on available amounts of pollen and nectar from a specific landscape element/habitat unit per each day of simulation. We consider floral resource models as ‘living’ models, as they are designed to be easily updated when more/additional data on pollen, nectar or sugar production, phenology of bee-friendly species or plant species composition in landscape elements/habitat units important for bees, become available.

All the details on methodology behind generation of floral resource models are available in the deliverables of the B-GOOD project (D3.1-D3.4); below we provide a short overview.

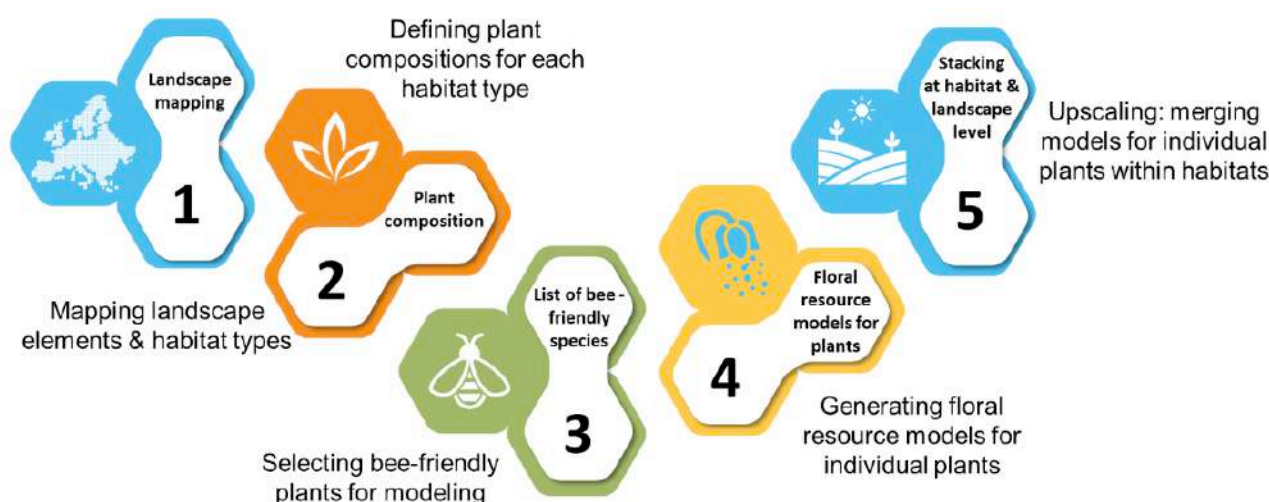


Figure 14 Modelling steps in generation of dynamic habitat- and landscape-level models of floral resource available to pollinators throughout the year.

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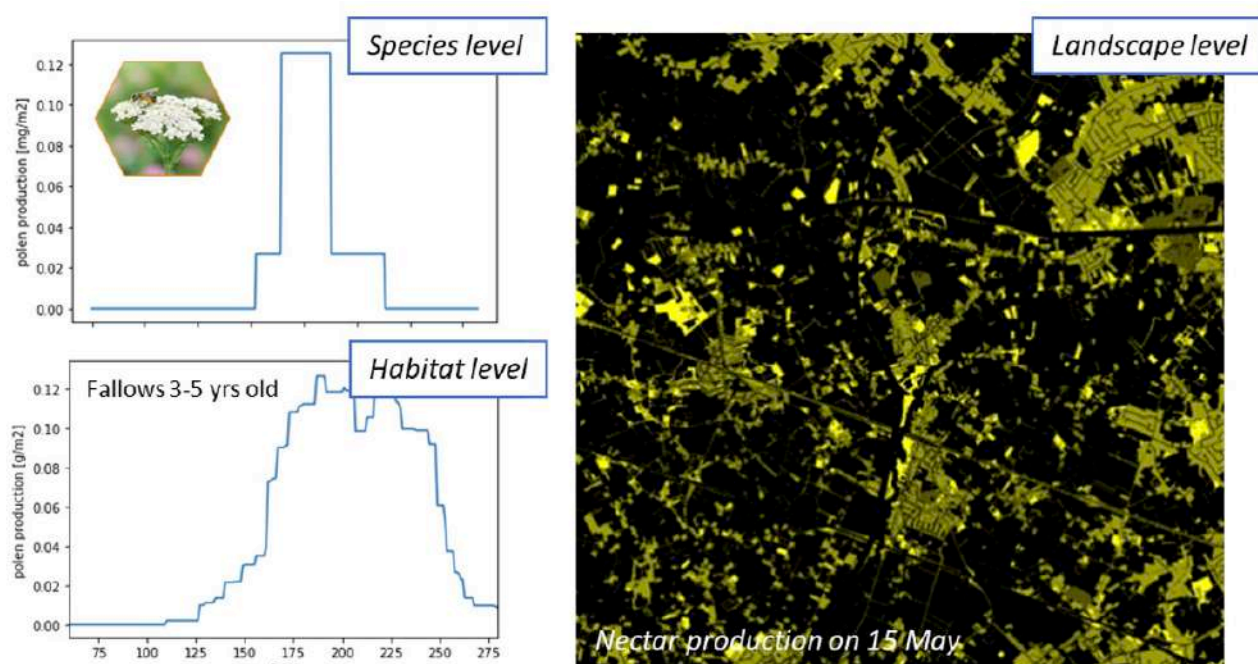


Figure 15 From floral resource models for single 'bee-friendly' species to habitat- and landscape-level assessment of floral resources available to pollinators on a daily basis.

2.3.1 Models of flowering phenology

In the current version of floral resource models, the timing of flowering is related only to temperature. This means that onset, peak and end of flowering are determined based on accumulated growing degree-days (*GDD*); i.e., degree days above the base temperature (T_b), a temperature threshold below which plant development stops. For calculation of daily GDD the following formula is applied:

Daily GDD (°C) = Daily Average T °C - T_b °C, where

Daily Average T °C = (Daily Max T °C + Daily Min T °C)/2

If daily GDD is below 0 or daily average temperature exceeds the maximum temperature for growth (T_{max}) (i.e., a temperature above which plant growth is inhibited), the daily GDD is set to 0 meaning that there is no increase in accumulated GDD for that day.

For all wild plant species, GDD are accumulated starting from 1st January and using the base temperature (T_b) and maximum temperature for growth (T_{max}) obtained using optimization procedures aiming at selecting the best fitted flowering phenology models according to the root-mean-square error (RMSE). For crops we used crop-specific base temperatures, determined from the literature. For permanent crops (i.e., fruits, olives), GDD are accumulated starting from 1st January while for annual crops they are accumulated starting from the sowing date.

Models of flowering phenology were fitted based on data gathered in the database on floral phenology, currently including more than eight million observations. This database integrates the following data sources:

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- (1) Pan European Phenology Database (PEP725): <http://www.pep725.eu/> (Templ et al., 2018). The database records observations on phenological development stages of plants using the BBCH-scale. For our purposes only observations with BBCH of 60 (beginning of flowering), 65 (full flowering), and 69 (end of flowering) were selected.
- (2) Phenological observations collected by the Deutscher Wetterdienst (German meteorological service, DWD) from 1951 to date accessed via Climate Data Centre OpenData server: https://opendata.dwd.de/climate_environment/CDC/. The observations of phenological development stages are described using specific codes of pheno-phases from 1 to 67 (description available at: https://opendata.dwd.de/climate_environment/CDC/help/PH_Beschreibung_Phase.txt), but in most cases the reference to the BBCH-scale is also provided. For our purposes only observations with codes of 5 (beginning of flowering), 6 (full/general flowering), and 7 (end of flowering) were selected.
- (3) Phenological information from the database on nectar and pollen production (Filipiak et al., 2022) as a product of the B-GOOD project. This database represents the first compilation of data on the various food resources produced by 1612 plant species belonging to 755 genera and 133 families, including crop plants and wild plants, annuals and perennials, animal- and wind-pollinated plants, and weeds and trees growing in different ecosystems under various environmental conditions. The data set consists of 103 parameters related to the traits of plant species and geographical and environmental factors, allowing for precise calculations of the amounts of nectar, pollen, and energy provided by plants and available to consumers in the considered flora or ecosystem on a daily basis throughout the year.
- (4) Phenological observations of development stages of selected crops (including data on start and end of flowering of winter oilseed rape) collected by the Polish Official Variety Testing (COBORU) in years 2007-2016.

- (5) Phenological observations from the multitaxon database on phenology from the Russian Federation, Ukraine, Uzbekistan, Belarus, and Kyrgyzstan. The data covers the period 1890–2018, with 96% of the data being from 1960 onwards. The database is rich in plants, birds, and climatic events, but also includes insects, amphibians, reptiles, and fungi. The database was restricted to plant flowering phenology observations within the spatial and temporal coverage of the E-OBS meteorological data.
- (6) Flowering phenological observations collected by Jachufa et al. (2021) for ‘bee-friendly’ species in human-made, non-cropped habitats of agricultural landscapes in SE Poland.

2.3.2 Pollen, nectar, and sugar production levels

Pollen, nectar, and sugar production from the floral unit (flower or inflorescence) of a given plant was assessed based on the database on nectar and pollen production ((Filipiak et al., 2022); see details above) or by additional literature searches and with an expert in pollination biology. For each analysed plant species, we calculated the mean production of pollen, nectar, and sugar from the floral unit, in µg per day, from all available measurements (from different habitat types, years, and locations). Often the total number of available measurements was very low, so it was necessary to pool measurements from different habitat types. In addition, the variance in floral resource production observed in between years and sites was often greater than between different habitat types. Where less than two independent measurements of pollen, nectar, and sugar production from flower/inflorescence in µg per day were available at the species level, the production of floral resources was estimated at the genus level or, if this was not possible, at the family level. The approximation of floral resource production at the genus or family level was verified with an expert in pollination ecology.

The habitat-level seasonal distribution of floral resources (pollen, nectar, and sugar) within a given year and in a given geographical location was estimated based on the mass of floral resources per floral unit, flowering abundance, and ground cover for each plant species concerning the phase of flowering following the equation presented by Jachufa et al. (2021):

$$M = (m \cdot a \cdot f \cdot c) / p$$

where:

M is mass of floral resource available from a plant species (g/m²/day); m is mass of floral resource from 1 floral unit (flower/inflorescence) (mg); a is flowering abundance (= number of floral units per 1 m²); f is flowering phase factor (= 0.15 for the beginning and termination of flowering; 0.7 for the full flowering phase); c is ground cover (%), and p is period of the flowering phase (days) in a given year and a given geographical location.

2.3.3 Composition of ‘bee-friendly’ plants in main landscape elements/habitat units and flowering density

For the main landscape elements/habitat units (such as woodland, grasslands, mires, bogs and fens, heathlands, shrubs and tundra), the ‘Database of relevant resources for honey bees’ produced within the B-GOOD project (as deliverable D3.1) was the main source of information. The database includes information on plant species occurrence and average plant species cover within the EUNIS (the European Nature Information System; <https://eunis.eea.europa.eu>) terrestrial Level 2 habitats divided into biogeographical regions. The EUNIS habitat classification is a pan-European hierarchical system that covers all types of habitats from natural to artificial areas, from terrestrial to freshwater and marine environments. The EUNIS habitat classification is a very detailed hierarchical system organized from Level 1 to Level 8, and across the different levels there are a total of 5284 different habitat types. Each habitat is identified with a specific and unique code, a name, and a description. In this case only the terrestrial EUNIS habitats at level 2 were used.

ALMaSS landscape maps contain several landscape element types important for bees but not included in the abovementioned database due to the small scale of these elements. ‘Bee-friendly’ plant compositions for these

landscape element types were obtained by merging information from Baldock et al. (2019), Jachuła et al. (2022), Jachuła et al. (2021), Schmidt et al. (2022), and data from field work performed within the B-GOOD project. The study by Baldock et al. (2019) provides information on floral resources of all major land uses in four British cities and was used to define plant composition in residential gardens and allotments, and urban parks. Studies by Jachuła et al. (2022) and Jachuła et al. (2021), investigate floral resources in man-made, non-cropped habitats in agricultural landscapes of SE Poland, and were used to define plant composition in railway embankments, road verges, woodlots and tree rows, fallows, and field margins. The study by Schmidt et al. (2020) analyses vegetation composition of perennial wildflower strips implemented across Saxony-Anhalt in Germany and was used to define plant composition in perennial flower strips, as these were one of the measures considered within the EcoStack project. Field work performed within the B-GOOD project aimed at determining the plant species composition of specific ALMaSS landscape elements and to confirm/validate the plant composition of some EUNIS habitat types, and was performed in Portugal, the United Kingdom and Belgium.

2.3.4 Implementation of floral resource models in ALMaSS

Floral resource models are formed into four input text files, that are read into ALMaSS and integrated into its landscape component to be able to generate each landscape element's (LE's) daily pollen and nectar amounts and quality per m². Two of them describe floral resource production levels and phenology data for individual plants, first for wild plants ('species_production_curves.csv'), and second for cultivated plants ('crop_production_curves.csv'). The third text file ('habitat_stack.csv') defines the composition of different habitat types. The fourth one ('crop_stack.csv') contains the information on density of floral units per m² for crop species. In addition, there are two lookup table files, the first mapping plant codes to plant names ('plants_lookup.csv'), and the second mapping habitat codes to habitat names ('habitats_lookup.csv').

The information on a habitat type for each polygon (of vegetated type) in a landscape is provided in the polygon reference file (see *Structure of landscape input files in ALMaSS* section) and is linked to information on the composition of 'bee-friendly' plants within that habitat provided in the 'habitat_stacks.csv' file (via the habitat code identifier). This structure provides a great deal of flexibility in defining habitat types within a landscape, as different habitat types can be assigned to the same landscape element type (e.g. high resource flower strips or low resource flower strips assigned to different elements of the same land use/land cover type being 'flower strips'), if such detailed information is available from field data or is being tested 'in silico' in the simulation.

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At the beginning of each ALMaSS simulation, the production of floral resources within a landscape model is pre-calculated for all simulation years based on provided weather input data. This means that for each simulation year, the timing of flowering and peak of flowering for each plant are pre-calculated based on temperature input and information on the GDDs required for flowering to begin and end, and the proportions of the flowering period for the beginning and end of the flowering peak. Daily production values of floral resources (pollen, nectar, and sugar) for a given plant are then calculated for each day of the simulation and accumulated for all plants composing a given habitat type to provide daily habitat-level production per unit area. In this way, each polygon in a landscape can be characterised by the amounts of floral resources available for each day of the simulation, and this information can be evaluated by the modelled organisms.

In summary, the pollen and nectar model within ALMaSS effectively captures the temporal and spatial dynamics of floral resources across various landscape elements, providing insights into the foraging behaviour and population dynamics of pollinators. An example of the simulated flower resource output from ALMaSS can be found in Figure 16.

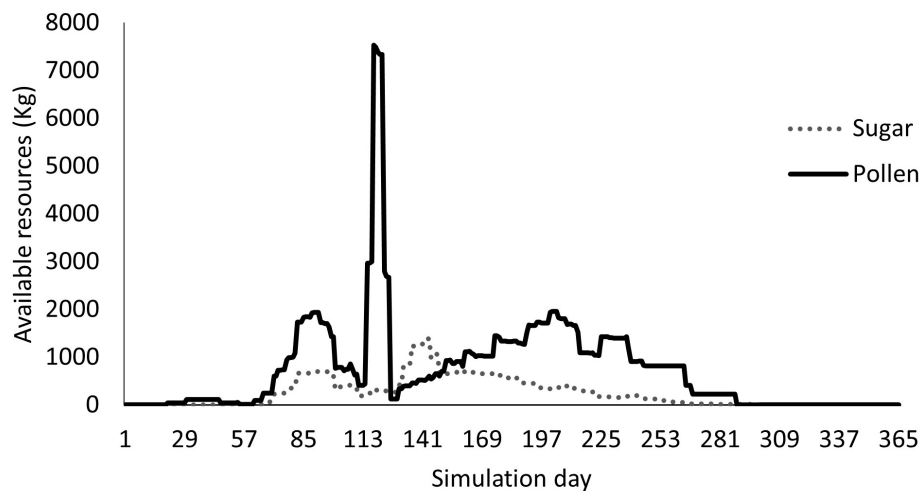


Figure 16 An example of the total simulated daily sugar (nectar quality) and pollen in a 10km by 10km ALMaSS landscape in one year in Denmark. The high peak in spring in this case is driven by pollen production by tree and indicates the dynamic nature of resource availability.

2.4 The ALMaSS Subpopulation Model

ALMaSS is a well-established suite of models recognized for its detailed agent-based models focusing on animals. However, certain insects, such as aphids, present challenges due to their exceptionally high population sizes and the absence of detailed individual behavioural data, rendering agent-based approaches either computationally prohibitive or impractical. Moreover, these insects may be depicted as a prey base for other species, such as ladybirds, necessitating an efficient method for accurate species modelling. In this context, we present a subpopulation-based approach designed to address the challenges posed by high population density and computational complexity.

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The key design objectives for the new approach were as follows:

- (1) Be capable of representing the entire population for the simulated landscape.
- (2) Include the detailed landscape representation and be able to interact with landscape, field and crop management.
- (3) Include spatial dynamics of the species.
- (4) Accurately represent the population development of the species.
- (5) Run efficiently on landscapes of standard 10 x 10 km.

The chosen methodology involved the modification of a conventional stage-structured population model to formulate a spatially dynamic model. Stage-structured population models, as outlined by (Lefkovitch, 1965), elucidate population growth by separating the population into stages, typically delineated by physiological life stages. The developmental trajectory of the population is then modelled by elucidating rates of transition from one stage to another. In the construction of the ALMaSS sub-population model, we used this fundamental concept to devise a universal population model amenable to adaptation for diverse species, each characterized by distinct life cycles and behavioural patterns. To introduce spatial dynamics, we partitioned the entire simulated population within the landscape into a grid of stage-structured subpopulations, each potentially interconnected with others through dispersal. Within each subpopulation, standard population processes such as reproduction, mortality, development, and dispersal were portrayed through discrete yet interconnected modules within the model.

This model's versatility extends to the capacity for representation across a broad spectrum of species by specifying parameter values for vital rates and modifying the structure of a table detailing the stage-structured population life cycle.

The implementation of the general subpopulation model within ALMaSS was achieved through the definition of two C++ classes. The “Subpopulation” class represents a single subpopulation, and an object of this class is used to simulate the stage-structured subpopulation in each grid cell (default 10m x 10m area). The “SubPopulation_Population_Manager” class is an administrative class that manages the entire population in the simulated landscape comprised of all Subpopulation objects and provides the input/output functions for the subpopulation model.

These two classes include all the necessary code to implement the subpopulation model, which can then be integrated into the standard ALMaSS landscape simulation model when an instance of the model is created. The ALMaSS landscape simulation model dynamically provides the modelled species with landscape-contextual information as the simulation runs.

2.4.1 The SubPopulation_Population_Manager class

This class represents the entire population in the simulated landscape as the whole collection of subpopulations. The subpopulations are defined by fixing a regular grid (default 10x10m) across the simulated landscape. For each grid cell, an object of the Subpopulation class is created and managed daily by the manager class. See Figure 17 for the running flow of the manager class, which shows initialisation and the daily time step loop until the simulation is done.

The running flow in the SubPopulation_Population_Manager class.	
1	Initialisation
2	Read the development file
3	Read the host file
4	Precalculate the landing masks
5	Creat the SubPopulation objects
6	repeat
7	DoFirst()
8	updateDevelopmentSeason()
9	updateMortalityArray()
10	relocatePopulation()
11	Loop all SubPopulation objects in parallel
12	BeginStep()
13	Nothing in this base class
14	Loop all SubPopulation objects in parallel
15	Step()
16	calPopuDensity()
17	calSuitability()
18	doMortality()
19	doMovement()
20	doDevelopment()
21	doReproduction()
22	Loop all SubPopulation objects in parallel
23	EndStep()
24	Nothing in this base class
25	DoLast()
26	doDevemopment()
27	doSpeciesLastThing()
28	addNewDay()
29	updateWholePopulation()
30	subpopuBaseOutputProbe()
31	until the end of the simulation

Figure 17 Running flow of the SubPopulation_Population_Manager class.

When an object of the manager class is created, initialisation will be called. In this step, the manager loads all the parameters (see Table 2) and segments the landscape into grids. An instance of a Subpopulation class is created in each grid cell. Grid cell suitability for the species is calculated based on the composition of the landscape within the cell and a long-distance dispersal landing masks pre-calculation is carried out to provide the basis for dispersal. After the initialisation, the manager starts the simulation loop with a one-day timestep (time unit applied to advance the state of the model), repeating until the simulation is completed. In each loop, the development season is updated first. Some species, e.g., black bean aphids, switch plant hosts depending on different life stages. If needed, the development season is defined based on this host switching point. Next, the common part of the mortality rate, identical for the whole simulated landscape at each time step, is also calculated. The flying animals will land using the landing mask based on the wind speed and wind direction for that day, and species-specific parameters altering this effect.

After these preparation steps in the DoFirst function, the BeginStep function is called for all the subpopulation objects. The function in this general method is empty, but the purpose of this function is to make the subpopulation objects ready for the loop of their Step function consisting of the population density, suitability and development, reproduction, mortality, and dispersal. Afterwards, the EndStep function is called to finish the day for all the subpopulation objects. Similar to the BeginStep function, the EndStep function is empty in the general class which requires override in the derived class if it is needed. After all the Subpopulation objects are looped, the common calculations (development and new day calculation), of which results are identical for the whole landscape and used by all the Subpopulation objects, are conducted in the DoLast function. Besides these calculations, the manager has two other functions: next life stage calculation and reproduction calculation, which the SubPopulation objects can call to determine life-stage transitions and reproductive outputs.

Table 2 Generic Model parameters

Name	Unit	Value	Symbol	Note
The number of life stages		5	N_l	Egg (0), larva (1), pupa (2), winged adult (3), wingless adult (4)
The maximum lifetime	Calendar day	200	N_c	The maximum alive days among all the life stages
Maximum degree days array	Degree days			The maximum degree days for each life stage
Base development temperature	°C	5		The lower temperature that the modelled species can accumulate day degrees
The size of the grid	Meter	10×10		Width and height
The flying array		3		Life stage, adult
The landing array		4		Life stage, adult
Winter host list (habitat)				TOLE (type of landscape element) in ALMaSS
Winter host list (crop)				TOC (type of crop) in ALMaSS
Summer host list (habitat)				TOLE in ALMaSS
Summer host list (crop)				TOC in ALMaSS

The suitability of grid cells is determined by the composition of the habitats and the plants they contain. Thus, a list of suitable host plants is needed. The host lists for the modelled species are loaded from an external text file. The host lists are stored for two seasons: summer and winter. This is because some species use different vegetation as hosts in summer and winter. Only summer lists are used if the modelled species does not switch hosts with seasons. For each development season, two lists are created, one for habitat types and the other for crops. The habitat list is used for landscape elements, for example, forests, buildings, and gardens. Arable fields are excluded from the habitat list but are represented by the crop list. This is because the vegetation on arable fields is not mappable but is determined dynamically by the farming simulation in ALMaSS.

In this part, the life stages that could fly are inserted into a vector, and the corresponding stages after landing are stored in another vector. This is because some species may drop their wings after landing.

The update development season function controls the development season. When the model species does not switch hosts, this function returns summer development as default which means only summer (yearly) hosts are used. In this general subpopulation model, we assume there is only one development season. If there is more than one in the derived class, this function requires an override.

Since the environmental factors, e.g., average temperature, wind speed and directions are identical for the whole simulated landscape, the base mortality rate depending on environmental factors is calculated in the manager class and stored. When the subpopulation object needs this, it doesn't need to be recalculated.

In this general subpopulation class, we assume that when the average environmental temperature (t_a) is below T_l or larger than T_h the model species will die, where T_l is the lowest temperature where T_h is the highest temperature. The base mortality rate (m_b) for all life stages is set as 0.1 when the daily average temperature is between the lower and higher boundary.

Since the whole simulated landscape has the same environmental temperature, the degree days used for the physiological age of the model species are calculated in the manager class at every time step. Each life stage has its base development temperature (T_m^i), where i is the life stage number). For each simulated day, the degree days (DD^i) are calculated using an equation based on the daily average temperature (T_a):

$$DD^i = T_a - T_m^i$$

The modelled species accumulate day degrees by the creation of a 2D array, $\mathbf{D}$, of which the first dimension is the index of the life stage ($i = 1, \dots, N_l$) while the second is the calendar day counter ($j = 1, \dots, N_c$). Each element $\mathbf{D}_{ij}$ is the accumulated day degrees for life stage i which are born or transition to that life stage at calendar day represented by j . All the elements of $\mathbf{D}$ are initialised with 0.

Besides this 2D array, each life stage has two variables for the oldest (o_i) and newest index (b_i) in the second dimension of $\mathbf{D}$. The oldest position o_i is where the oldest alive population exist in $\mathbf{D}$ for life stage i . The newest position b_i is where the new-born/new-developed population should be added for life stage i . From the beginning, both the oldest and newest indices start as 1. In the end of each day,

1) The newly accumulated day degrees will be added to $\mathbf{D}_{ij}$ for the positions that meet the equation:

$$j \in \begin{cases} [o_i, b_i], & \text{if } b_i \geq o_i \\ [1, b_i] \cup [o_i, N_c], & \text{if } b_i < o_i \end{cases}$$

2) The newest position is added by 1 to move to the next day. If the newest position is larger than N_c after the addition, it will be set to 1.

3) For each life stage, the accumulated degree days pointed by the oldest index are compared with the maximum development degree days for each life stage, if it is larger than or equal to the maximum one, the oldest index will be inserted into the ready-to-next-life-stage array. The accumulated day degrees in $\mathbf{D}$ indexed by the oldest index will be reset to zero. Afterwards, the oldest index will be added by one. If it is larger than N_c , the oldest index will be set to 1. This check and addition will continue until the accumulated degree days at the oldest index are less than the maximum development degree days.

There are two functions linked to development calculation, 1) supplyOldEnoughIndex function returns the ready-to-next-life-stage array which will be used by the SubPopulation class. 2) supplyAgeInDay function returns the age in calendar days for the given life stage and index in the second dimension of **D**. To calculate the age of the population has the accumulated degree days at D_{ij} in calendar day (a_{ij}^c), using the equation:

$$a_{ij}^c = \begin{cases} b_i - j, & \text{if } b_i \geq o_i \text{ or } b_i < o_i \wedge b_i > j \\ N_c - j + b_i, & \text{if } b_i < o_i \wedge b_i \leq j \end{cases}$$

There is a function to calculate the next life stage when the modelled species at one life stage has accumulated enough degree days. This function needs to be overridden in the derived class. For the general subpopulation class, it has five life stages, namely, egg (0), larva (1), pupa (2), winged adult (3), unwinged adult (4). The number in the brackets is used to represent the life stage while -1 means death. If the current life stage is l_c , the next life stage (l_n) can be calculated using equation:

$$l_n = \begin{cases} -l_c + 1 & l_c < 2 \\ -1 & l_c \geq 3 \\ 3 \text{ or } 4 & l_c = 2 \end{cases}$$

A reproductive function calculates the number of offspring and the life stage number of the offspring for the given life stage. This function is called by the reproduction function in the SubPopulation class. For the derived classes, this function must be overridden, for example because species like aphids can lay eggs or give birth to nymphs.

The long-distance dispersal function is used to pre-calculate the landing mask when the modelled species do the long-distance dispersal for the sake of computing efficiency.

We assume the long-distance flying dispersal is driven by the wind. Further, it only happens when the wind speed is lower than a certain value. The long-distance flying is done by using 2D landing masks, which are generated by the landing proportion 1D curve along the wind direction. Below are the key parameters with the default values in the parenthesis for the long-distance flying dispersal as defaults.

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Maximum wind speed, w_M (12m/s): When the wind speed is larger than w_M , the modelled species will not attempt to fly.

Wind step size, w_s (2m/s): This is used to sample the wind speed to discrete ranges. Each range has four landing 2D masks in four wind directions.

Peak distance, d_p (100m): This is the distance where most of the flying ones can land along the wind direction when the wind speed is in the first range (0 to w_s).

Longest distance, d_l (1000m): This is the longest distance at which the flying ones can land along the wind direction when the wind speed is in the first range (0 to w_s).

Wind speed scale, s_w (1.2): This is the scale used to increase the peak and longest distance when wind speed increases to one range from the previous range.

Two polynomial functions are used to generate a long tail landing curve along the wind direction:

$$p(l) = \begin{cases} -l^2 + 2d_p l, & \text{if } l \leq d_p \\ \frac{d_p^2(d_l - l)^2}{(d_l - d_p)^2}, & \text{if } l > d_p \text{ and } l \leq d_l \end{cases}$$

where l is the distance from the landing position to the original position. In this way, the position at d_p will have the largest landing proportion compared to other positions. The flying individuals can land at a maximum distance of d_l , beyond which no one can land. Detailed information about the landing in a 2D landscape can be found in the Aphids Movement section.

2.4.2 General remarks

In the species modelling section below, this basic subpopulation model has been used to simulate four different aphid species. This process is not entirely simple because of the need to fuse the relatively simply stage-structured population model concept with the details simulated in the ALMaSS landscape, giving rise to a model of medium complexity. The flexibility to cope with different lifecycles and host seasons adds further parameters to the models. However, this model allows a completely new approach to modelling populations in ALMaSS and thus increases the utility of the system. The parameters used for the four aphid species can be found in the Aphids (*Aphis fabae*, *Acyrtosiphon pisum*, *Myzus persicae* and *Sitobion avenae*) modelling section (see section 2.5.5).

2.5 Species modelling

The species chosen for modelling represent generalist and specialist pest control agents, a pollinator, aphid pests, and important agricultural landscape vertebrates.

Generalist predators, such as spiders and carabid beetles, play a crucial role in regulating pest populations. To effectively control pests, these predators need to be present in high densities from the early stages of pest outbreaks. However, agricultural fields are dynamic and ephemeral habitats, characterized by varying habitat quality and disturbance. Crop type and growth significantly impact habitat quality, affecting plant cover, microclimate, and prey availability. Additionally, crop management practices, including tillage, harvest, and insecticide applications, cause significant mortality to both predators and their prey, rendering the fields unsuitable for predator survival. This agricultural management can deplete predator populations through direct mortality and subsequent dispersal of survivors. Therefore, predators in agricultural fields experience rapid fluctuations in habitat quality, creating a complex spatial dynamic system through their dispersal activities.

Spiders, represented here by *Erigone atra* and *Euopaeus fuscus*, are soft bodied and particularly vulnerable to disturbance. The population of spiders in a single field may need to recover multiple times throughout the year. This cannot solely be achieved through reproduction, emphasizing the importance of immigration. Immigration rates depend on both the dispersal characteristics of the spider species and the composition of surrounding habitats. Linyphiids, a common genus of spiders, are adept at aerial dispersal (ballooning), enabling them to travel large distances. Therefore, linyphiid population dynamics in a single field are influenced not only by the immediate surroundings but also by the larger landscape context. Sunderland and Samu (2000) demonstrated this landscape-scale influence, highlighting the importance of considering the entire landscape in understanding linyphiid population dynamics.

Carabid beetles are another group of important generalist predators, represented here by *Bembidion lampros*. These are much less dispersive than the spiders considered, but also less vulnerable, spending much of their life cycle in the soil. As such the impact of landscape structure on these species is rather different and contrasting to the spiders. Behaviour of *B. lampros* is characterized by annual dispersal and aggregation phases with aggregation linked to non-cultivated habitats and dispersal and breeding largely occurring in open areas. Thus, the populations of *B. lampros* in agricultural landscapes largely depends on presence of overwintering grassy habitats such as field margins, and on the type of agricultural management related to soil cultivation.

We have chosen *Osmia bicornis*, the red mason bee, to represent wild pollinators. This is just one of many pollinator species in agricultural landscapes, but represents solitary bees which provide an important ecological and agricultural service by pollinating both wild plants and crops, often more effectively than honey bees. They are likely to be both at risk due to agricultural operations but are also responsive to habitat manipulation (especially related with nesting). *O. bicornis* is an important pollinator in European agricultural landscapes and is often reared on a commercial scale to be used as a managed alternative pollinator, especially in orchards. It

is commonly used for laboratory and field studies on wild bees, including studies of pesticide toxicity, and thus its biology and ecology are relatively well known.

Our specialist predator-and-pest system is represented by the seven-spot ladybird (*Coccinella septempunctata*), and four common arable aphid pests, the black bean aphid (*Aphis fabae*), peach potato aphid (*Myzus persicae*), English grain aphid (*Sitobion avenae*), and the pea aphid (*Acyrtosiphon pisum*). *C. septempunctata* is of the key aphid predators in temperate agricultural landscapes of Europe, but there is evidence that its populations are declining. This can be explained by sensitivity of the species to land use changes (habitat degradation) and agricultural intensification. The use of *C. septempunctata* to control aphid populations has been a common practice for decades but the interactions within this predator-prey system at the landscape level has not been fully understood.

The vertebrates are represented by the skylark (*Alauda arvensis*), a typical ground nesting bird of agricultural landscapes, the hare (*Lepus europaeus*), a declining but common and huntable species, and the field vole (*Microtus agrestis*) which is an indicator species for undisturbed grassland, and a keystone species as prey for higher trophic levels.

2.5.1 Spider (*Erigone atra*)

Spiders are considered to be important pest control agents in arable crops (Nyffeler and Benz, 1987). They are generalist predators, working alongside specialists to control populations of pests. Linyphiid spiders are probably the most abundant and important of these in northern and central European fields. One of the representatives of this family is *Erigone atra*, a species of dwarf or money spider. It has a very wide global distribution occurring in Europe, parts of Russia, North America, Central Asia, China, Japan. Together with similar ecotypes, *E. atra* is an important beneficial predator, preying on pests such as aphids. *E. atra* commonly engages in ballooning for dispersal. This technique involves releasing a silk thread into upwardly moving air until the drag on the thread is enough to lift the spider aloft. This dispersal method allows *E. atra* spiders to traverse large distances and is often used to avoid adverse conditions (Weyman et al., 2002, Weyman et al., 1994). Dispersal by ballooning can occur at any age after hatching.

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The ALMaSS *Erigone atra* model was developed by Thorbek and Topping (2005) and a description of the processes included can be found at

<https://projects.au.dk/fileadmin/dmu.dk/en/animalsplants/almass/species/spidermodeldescription.pdf>.

The model simulates the development, reproduction, mortality, and movement of individual spiders in response to habitat quality, weather conditions, and crop management activities. It comprises three object types: sedentary eggsacs, and mobile juveniles and females. Males have been excluded from the model, assuming that their presence will not be limiting. The spiders can exhibit various states or behaviours, as illustrated in Figure 18. Transitions between these states are governed by rules, and the decisions made can be influenced by the spiders' history, internal state, or external events, including crop management activities.

This species' key characteristic is that it is highly reproductive and highly dispersive. It can disperse all year if weather conditions are suitable and has a plastic life-history being variably multivoltine potentially overwintering as adults or juveniles. It is therefore capable of recovering population size after perturbation as long as there are some refuges available in the landscape (Torbek and Topping, 2005).

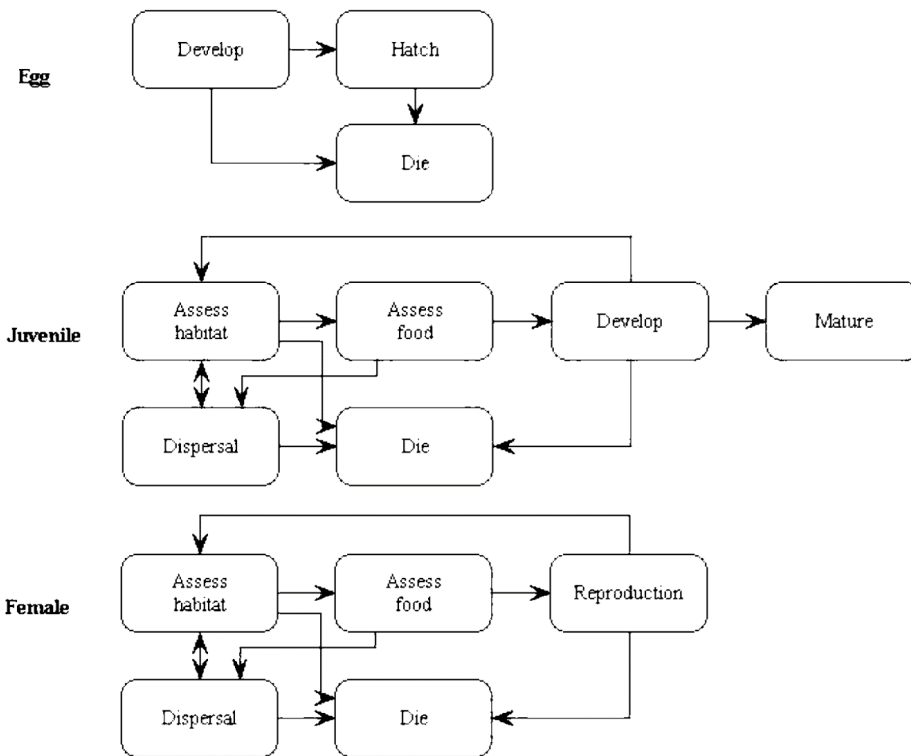


Figure 18 The state-transition diagram for ALMaSS spiders. This basic description of behaviours is consistent for both the *E. atra* and *O. fuscus* models.

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2.5.2 Spider (*Euopaeus fuscus*)

The model for *O. fuscus*, another representative of the Linyphiid spiders, was developed under the EcoStack project and no formal model has yet been published. This species is also common in agricultural fields and is an important aphid predator. It is sensitive to agricultural management regimes, particularly the frequency of management. *O. fuscus* differs from *E. atra* primarily in its reproductive, growth and dispersal behaviour, detailed below.

2.5.2.1 Dispersal

According to the available data (Søren Toft, unpubl.), the ballooning period for *O. fuscus* is limited. To model this, the dispersal algorithms were altered such that the spiders only balloon in April-June under Danish conditions. When outside these months, they move 1 m in semi-random direction, whenever they would otherwise want to balloon (also in non-suitable ballooning weather). Since we do not know the differences between adult and juvenile ballooning for *Oedothroax* we have used the same behaviour as for the adults.

2.5.2.2 Habitat assessment

Habitat acceptance is slightly more restrictive than *E. atra*, but the difference is minor. This species has a slightly higher preference for grass compared to *E. atra*.

2.5.2.3 Development and egg sac production

Field data suggest that *O. fuscus* takes approximately one third longer to produce an egg-sac than *E. atra*, hence egg-production is scaled by 1.33. Other development constants for the biophysical model are as below and are estimated from literature sources and unpublished data.

The biophysical model (Wagner et al., 1984) was used for temperature relationships for reproduction and growth:

$$Rate(T) = RHO25 \frac{T}{t} \exp \left[\frac{HA}{R} \left(\frac{1}{t} - \frac{1}{T} \right) \right]$$

where T is temperature, $t = 298K$, R is gas constant (1.987), and $RHO25$ & HA are stage-specific constants (see below).

Parameter values used were taken from Thorbek et al. (2002) and Dekeer and Maelfait (1987) shown in Table 3 and Table 4 respectively.

Table 3 Egg production and development thresholds taken from Thorbek et al. (2002).

Parameter	Literature value
Egg Development Threshold	0
Egg Development RHO25	0.1132253
Egg Development HA	16894.22
Egg Production Threshold	7
No. female eggs per sac per month	0, 0, 12, 8, 8, 8, 11, 10, 0, 0, 0, 0

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Table 4 Juvenile development thresholds taken from Dekeer and Maelfait (1987).

Parameter	Literature value
Juv Development Threshold	0
Juv Development RHO25	0.0943
Juv Development HA	23457.22
Juv Development Intermediate	0.66*
Juv Development Poor	0.33*

* Factor to multiply developmental rate by at intermediate and poor food levels

Modelled species phenology is shown in Figure 19. We estimated that the production of eggs in the model occurs approximately two weeks after real field conditions. However, we have no solid data to back up this supposition. If there is a serious discrepancy, it is probably due to the inadequate data on egg-sac production and development at lower temperatures. These low temperatures (<5°C) are often experienced in the field but are rarely tested in the lab. The problem arises when lab data show a linear relationship between temperature and time to hatch (as they do in the case of *O. fuscus*), but that the data does not extend to these low temperatures. At lower temperatures the linear relationship breaks down, as it becomes curved. Thus, development often occurs below the thermal development threshold predicted by the laboratory data.

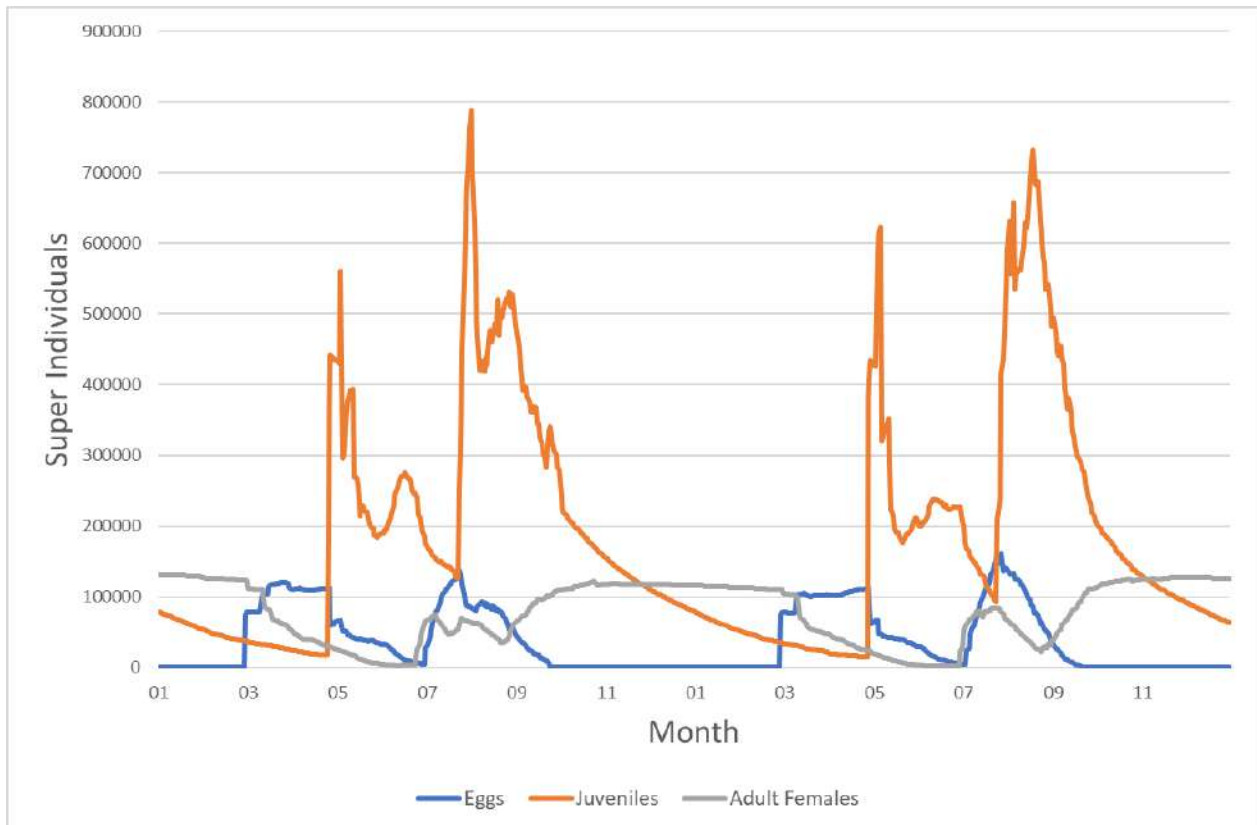


Figure 19 The phenology of modelled *O. fuscus* under Danish weather conditions. The graphs show two years of phenology with clearly defined double production of eggsacs followed by the appearance of two peaks of juveniles.

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2.5.3 Ground beetle (*Bembidion lampros*)

B. lampros represents a group of spring-breeding, carnivorous ground beetles of temperate agricultural landscapes important for natural pest control. The importance of this species in pest control results from its high population densities and early dispersal to the fields. *B. lampros* is widespread in the agricultural landscapes in central and northern Europe (including Finland and Sweden; see for example Mei et al. (2023), Helenius et al. (2001)). It has been also indicated as relevant for risk assessment of pesticides according to the EFSA Scientific Opinion addressing the state of the science on risk assessment of plant protection products for non-target arthropods (EFSA, 2015).

The original ALMaSS model for the carabid beetle *B. lampros* was described by (Bilde and Topping, 2004), and the online ODdox documentation is available at:

https://projects.au.dk/fileadmin/dmu.dk/en/animalsplants/almass/ALMaSS/Carabid_B/index.html. Due to the substantial number of beetles in the real world, the model employs the super-individual concept. This implies that each beetle agent in the model represents 100 real-world beetles (Topping et al., 2015). The behaviour of *B. lampros* is simulated daily, and all individuals are classified into four life stages: egg, larvae, pupae, and adult female (males are not modelled as they do not influence the population size). Behaviour is characterized by annual dispersal and aggregation phases, with aggregation linked to non-cultivated habitats (e.g., field margins), and dispersal and breeding primarily occurring in open areas.

The most significant drivers in the model are temperature-controlled developmental rates of eggs, larvae, and pupae, in conjunction with adult female interactions with the landscape. At high densities, the model incorporates density dependence through intraspecific predation. Furthermore, *B. lampros* responds to in-field

farming activities, with beetle mortality values for soil cultivation and harvest operations defined based on Thorbek and Bilde (2004).

The original ALMaSS model for *B. lampros* was developed and tested using field and phenological data for Denmark, therefore, to ensure population survival it was necessary to adapt the model to other climatic regions and for each country studied separately (similarly as in Ziółkowska et al. (2021)). This involved adjusting the winter mortality and hibernation date parameters in Finland (see appendix 1). In addition, soil temperature at depth of 3.5 cm was used instead of air temperature to assess winter survival of beetles and duration of developmental stages occurring in the soil.

The *B. lampros* ALMaSS model is one of the most demanding on CPU time, with model populations often exceeding 50 million agents, even with the super individual concept in use.

2.5.4 Ladybird (*Coccinella septempunctata*)

The ladybird beetle, *Coccinella septempunctata* L. (Coccinellidae: Coleoptera) is well known and widespread entomophagous predator beetle feeding on soft bodied insect pests. Both the adult and larval stages of the *C. septempunctata* feed primarily on diverse aphids, therefore, playing an important role in biological control of these pests worldwide. Although native from Europe, Asia and Northern Africa, *C. septempunctata* is now common also in North America where it was introduced already in 1956 as biological agent against general species of aphids in agricultural crops. Using ladybirds to control aphid populations has been a common practice for decades. However, recently, due to advance of the organic farming and increased awareness about the use of pesticides and their role in the loss of biodiversity the use of insect species as biological control agents that can beneficially influence agricultural practices gained additional interest.

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Although *C. septempunctata* can feed on various types of food, it cannot develop or reproduce on non-aphid food. Therefore, predicting the presence of aphids within the landscape and its changes in time and space is crucial for determining the behaviour of seven-spotted ladybirds.

The most important is work done by (Bianchi and Van Der Werf, 2003, Bianchi and van der Werf, 2004). They worked with a spatially explicit population model for the population dynamics and foraging performance of *C. septempunctata*; but rather a GIS based population model, not an IBM. Whereas, in this model, we used an agent-based modelling approach (Grimm and Railsback, 2005). In agreement with this approach, each individual ladybird beetle will be represented by a separate code object with defined properties (like age, appetite, or the number of ovarioles developed). Each object in our model can be in one and only one state.

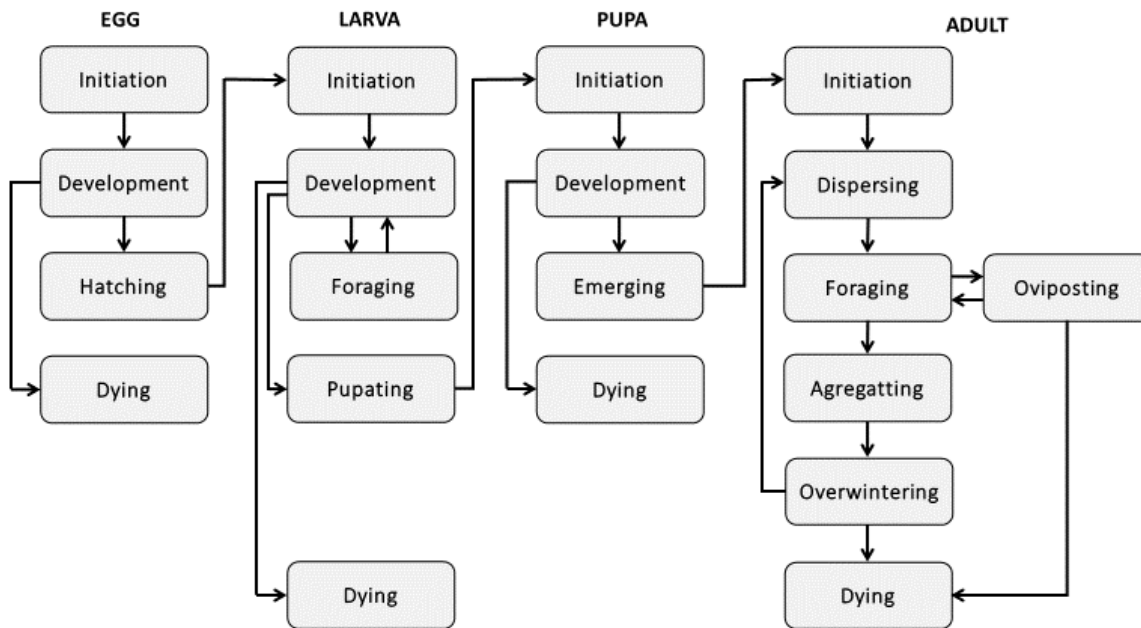


Figure 20 The state transition diagram for the *C. septempunctata* classes.

Coccinella septempunctata is a classic example of a highly specialised forager, that preys on particular species of aphids and adjusts its lifecycle accordingly. It requires that aphid models developed for ALMaSS a run in parallel with this model to provide a food source. Individuals move between different states during their lifetime, defining their physiological or developmental status. The behaviour and transition of each life-stage are shown in Figure 20.

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For many of the behaviours implementation was based on the papers by (Bianchi and Van Der Werf, 2003, Bianchi and van der Werf, 2004) many of which use (Xia et al., 1999) as a basis.

The ladybird (*C. septempunctata*) model is a rather large and complex model compared to most ALMaSS insect models and is fully described in a formal model article (in preparation), which is some 50 pages long. Key behaviours modelled include:

2.5.4.1 Oviposition

This behaviour is linked with photoperiod, temperature, and food availability. If the weather is warm and it is during the breeding season, the *C. septempunctata* will oviposit in areas with high enough aphid populations. These factors are evaluated daily, and eggs are laid until the *C. septempunctata* dies or has successfully laid its full complement of eggs. We assume that the *C. septempunctata* is univoltine, which is the case over most of the central and norther European range.

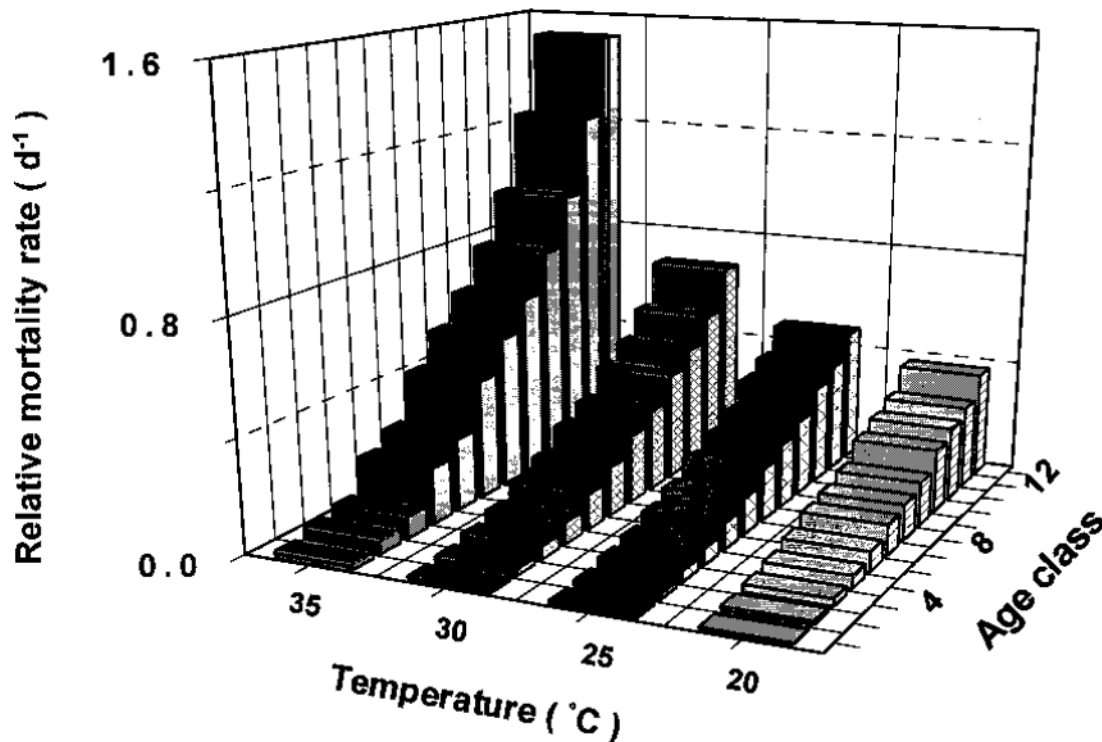
2.5.4.2 Growth

Egg development and larval growth are modelled following (Xia et al., 1999), and like oviposition are heavily dependent on temperature and food supply. We consider eggs, four larval stages and pupae. Adults emerge fully formed and do not grow but require a pre-oviposition maturation which is assumed to be a fixed period after activity starts in spring.

Linear day degree models were used in conjunction to curvilinear prey relationships to determine the daily growth of predatory stages.

2.5.4.3 Mortality

Mortality is implemented in four ways. The first is a stage-related unspecified daily mortality rate that represents all forms of mortality and is a temperature and food supply related (Figure 21, based on Xia et al. (1999)). The second is mortality under extreme conditions, e.g. extreme cold. The third is as a result of cannibalism (see below).



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Figure 21 From Xia et al (1999), age class-dependent relative mortality of adults feeding on cotton aphids at four temperatures.

2.5.4.4 Cannibalism

We assume that all larval stages can cannibalise the smaller stages but will only do so when aphid food falls below a critical level. Cannibalisation can only occur if the target is present in the same location as the one eating it. Cannibalised ladybirds provide high quality food and allow development in the larger stages when aphids become scarce. Adults are never the target of cannibalism in the model, but they can cannibalise all the smaller stages to eggs.

2.5.4.5 Movement

During larval and adult stages of their development ladybirds (*C. septempunctata*) engage in movement. Eggs and pupa do not move. While larvae can only walk, the adults combine walking with flying. Adult *C. septempunctata* often do not remain long in any given location, but instead appear to move frequently between sites and habitats throughout the breeding season (Ferran and Dixon, 2013). For categorization purposes we divide the movement into long range and short-range movement. The habitats that support ladybird population are generally dependent on the presence of aphids in the breeding season.

Long Range Movement occurs when the ladybirds fly to move to and from hibernation (to and from hibernacula). In addition, at times of low food abundance coccinellids sometimes perform prolonged flights, usually searching for new foraging sites. More normally short-distance dispersal is used to move to new foraging or oviposition sites. For adults walking or taking short flights, the dependence between the daily

distances covered and the temperature was implemented through the maximum daily time-budget and withing a temperature window. There are two movement types implemented:

- Short-range movement (walking or short flights, considered as walking). This movement is used to simulate intensive search behaviour when the ladybird or larva scans the local surroundings in search of prey. This takes repeated steps until either maximum movement distance is reached or a suitable density of aphids is found.
- Long-range movement (flying). The extensive search for a different type of landscape or vegetation. This movement could be either part of aggregation or dispersal behaviour or a response to insufficient resources at the current location.

The mechanism of the movement is as follows. If there are enough aphids in the current location the ladybird will only engage in random movement (a single short-range movement step). However, if there are not enough aphids to sustain the individual, it will attempt cannibalisation and if there is still some movement left to do today, it will perform a short-range movement.

2.5.4.6 Diapause

Diapause is a complex behaviour that allows individuals to alter or completely stall some of the biophysical processes in their bodies. In ladybirds, the adaptive functions of diapause are: (i) to synchronize the development of active stages with favourable conditions and (ii) to enhance the survival potential during unfavourable periods. Such periods could be both the prolonged periods of sub-zero temperatures and overly hot and dry seasons that can occur in summers (aestivation diapause). However, in the model, we only implemented overwintering diapause, leaving aestivation diapause aside. We ignore aestivation because we are interested in using the model in Northern and Western Europe, where literature reports this behaviour as rare. When looking for diapause sites the ladybirds in the model will find suitable natural vegetation and will form hibernacula of 1-20 in individuals. The photoperiod drives the end of overwintering. The first day when the day length T_{day} is longer than a threshold t_E is a first emergence day. Once this point is reached there is a daily chance of emerging from the hibernacula.

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2.5.4.7 Foraging

Due to ladybirds' role as natural enemies, the relationship between the coccinellids and their prey was one of the first areas of study. Therefore, work has been focussed on understanding the ladybird prey-searching patterns, prey preference, and the influence of the diet on ladybirds. We include searching and handling time, as well as prey density to determine the food intake rate (predation rate) on aphids, with the simplifying assumption that all aphids are equal sized. Food intake rate is also determined by ladybird life-stage and for larvae increases with size.

2.5.5 Aphids (*Aphis fabae*, *Acyrtosiphon pisum*, *Myzus persicae* and *Sitobion avenae*)

The aphid model was developed under the EcoStack project, and no formal model has yet been published. A subpopulation approach was taken to represent the millions of aphids in the population. However, this limits the detail in which individual interactions are specified; thus, the model will not represent feedback related to individual characteristics. For instance, (Llewellyn and Brown, 1985) showed that adult weight positively correlates with fecundity, but this process cannot be represented in a sub-population model.

For holocyclic aphid species each year, aphid stem mothers appear in spring. The stem mothers are developed from eggs that are produced later in summer/autumn in the previous year. Stem mothers will produce nymphs which will develop into apterous/alate. Aphid nymphs have four instars with varying development requirements. Aphid nymphs are unable to reproduce and fly (Capinera, 2008). Aphids reproduce, for most of

the year, parthenogenetically. Parthenogenetic reproducing females can be wingless (*Apterous virginoparae*) or winged (*Alate virginoparae*) (Capinera, 2008). Aphids produce winged and unwinged morphs that only differ phenotypically (Ogawa and Miura, 2014), and sexual morphs (Males and females). The latter are produced in autumn in response to environmental cues, such as decreasing temperatures and short-day conditions. The morphs/life stage that will be included in the model are egg, nymph, *Apterous virginoparae* (unwinged asexual female), *Alate virginoparae* (winged asexual female), male, *Apterous oviparae* (unwinged sexual female) as shown in Figure 22. We will not discriminate winged and wingless males in the model since the males can be winged and wingless (Shingleton et al., 2003) and all the females are mated by default. Some common variables, e.g., age in days, accumulated degree days, maximum degree days, for each life stage can be found in Table 5.

Development describes the development rate for nymphs and longevity for adults (Influenced by temperature). Reproduction calculates the rate at which offspring is produced (Sexual/Asexual), determined by environmental temperature and age. Movement determines the direction, timing and distance that winged aphids can fly. Morph determination determines which type of nymphs are born (Male, ovipara, *Apterous virginoparae* or *Alate virginoparae*), influenced by photoperiod, aphid density and host quality. Mortality calculates how many aphids die each day based on ladybird interactions, temperature, and density. We present a detailed description of the processes in the following sections.

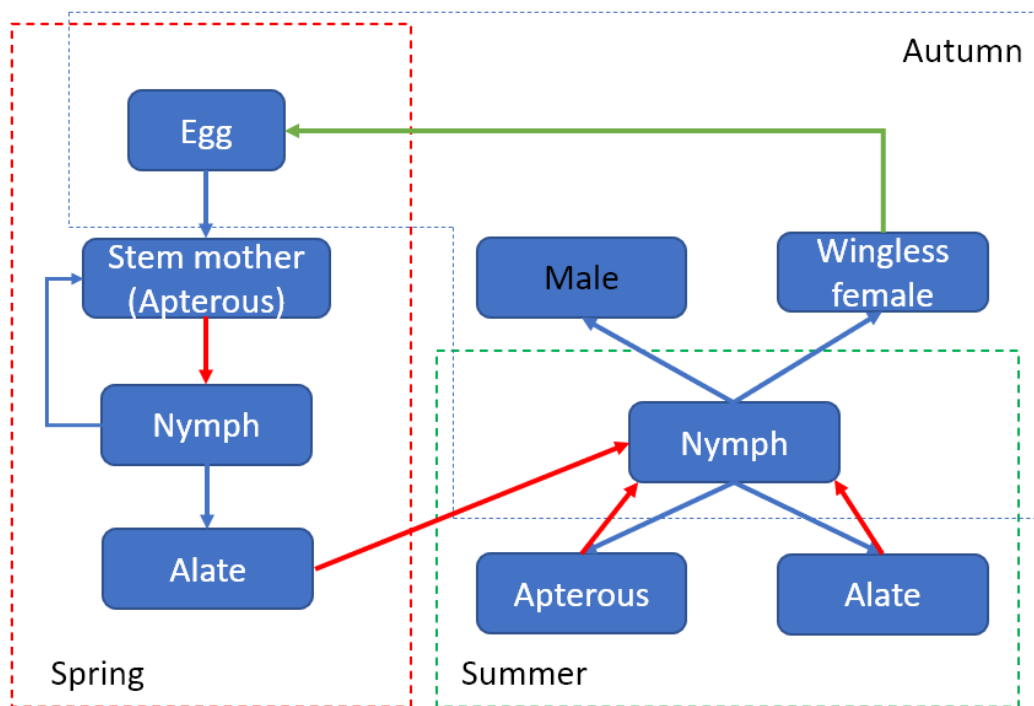


Figure 22 General homocyclic life cycle. Blue arrows indicate reproduction, red development and green egg production.

Table 5 Common variables for all life-stages

Variable name	Units	Description
Age	Days	Accumulated days since egg or development
Accumulated degree days	Degree Days	Accumulated days for every life stage – Starting from 0 for each stage
Maximum degree days	Degree days	Degree days needed to move to the next life stage or Death
Daily mortality rate	Percentage	Percentage of each age class for each morph in each cell to be killed at the end of a day

2.5.5.1 Development

The Development describes the rate at which nymphs develop into adults, how long eggs take to develop and the life expectancy of adults. The development time is assumed to be linearly dependent on temperature, therefor Degree days (DD) are used to describe those development times. In addition to that development of different morphs (winged morphs and sexual morphs) is determined by environmental factors. Those parameters are also named development. A thermal constant (k) is used determine development times for nymphs and eggs. For adults' longevity (Age-specific survival) is determined by a degree-day model, assuming a linear relationship between temperature and longevity. Development for- all morphs is calculated according to Equation (1).

$$DD = \begin{cases} 0, & T < LDT \\ T - LDT, & T \geq LDT \end{cases} \quad (1)$$

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Eggs only develop after exposure to cold temperatures preventing early hatching (Bonnemaison, 1951). During the winter, eggs enter diapause, a period of slow, temperature-independent development, followed by a temperature-dependent development (Shingleton et al., 2003). Complete egg development takes approximately 100 days until it hatches (Miura et al., 2003). As information on the egg development of *A. pisum*, *A. fabae*, *M. persica* and *S. avenae* was not found in the literature, thermal requirements of *Myzocallis coryll* and *Dysaphis plantaginea* aphid species were used as a starting point to calibrate the thermal requirements for eggs in the aphid model (Graf et al., 2006, Messing and AliNiazee, 1991). The linear function used to calculate the hatch chance of eggs based on degree days accumulated above the lower development threshold are shown in Table 6.

Table 6 Functions used to simulate aphid egg development. The function value was used as the hatching chance of the eggs.

Aphid	Function	Lower development threshold (°C)
<i>A. pisum</i>	$0.0029x - 0.233$	3.5
<i>A. fabae</i>	$0.0029x - 0.160$	5.0
<i>M. persica</i>	$0.0029x - 0.160$	3.5
<i>S. avenae</i>	$0.0029x - 0.160$	3.5

Aphid nymph development has been shown to linearly correlate with temperature, within the lower and upper development threshold (LDT/UDT, in °C) (Bieri et al., 1983, Hutchison and Hogg, 1984). However, as the temperature gets closer to the development thresholds (LDT/UDT), this relationship starts to differ. The implemented development thresholds and thermal constants for the four aphid species are shown in Table 7.

Table 7 Aphid nymph development parameter. Thermal constant in degree days (DD), Lower development threshold (LDT) in °C. Brackets indicate literature value if present. The number in front of the brackets is the implemented value.

Species	Thermal constant (DD)	Lower development threshold (LDT)	Source
<i>A. pisum</i> -winged	148.59+-4.48	2.73	(Hutchison and Hogg, 1984)
<i>A. pisum</i> -unwinged	140.25+-2.62	2.73 (2.73)	(Hutchison and Hogg, 1984)
<i>A. fabae</i> -winged	192	2.73	Assumed
<i>A. fabae</i> -unwinged	173+-15.72	2.73	(Akca et al., 2015)
<i>M. persica</i> -winged	119.8+-1.3	3.5	(Liu and Meng, 1999)
<i>M. persica</i> -unwinged	133+-1.2	3.5 (4)	Assumed
<i>S. avenae</i> -winged	142	2.73	Assumed
<i>S. avenae</i> -unwinged	128.99+-10.33	2.73 (4)	(Özder, 2002)

2.5.5.2 Mortality

Egg mortality is assumed to be constant 70% mortality rate for all aphid species, based on the data presented in Leather (1993). This value was transformed into a daily mortality rate assuming an average egg development period of 100 days, which result in that eggs will have a daily chance of 1.19% +-0.077 to die in the model. The downside of this approach is that egg survival rate in effect will be determined by average winter/spring temperatures, as low average winter/spring temperatures will cause the egg to develop for a longer period, thereby increasing the total amount of egg mortality. While higher winter temperatures would cause less egg mortality in addition to the earlier hatch date.

Nymph and adult morphs experience density dependent and density independent mortality. Density independent mortality is applied as a constant background mortality to simulate the effect of generalist predators. The effect of generalist predators is simulated by a constant 2.5% and 2% mortality rate for *A. pisum* /*S. avenae* and *A. fabae*/*M. persicae* respectively. Delayed density dependent mortality is simulated by equation (2), adapted from (Snyder and Ives, 2003). This simulates the delayed density-dependent mortality due to disease, decrease in host quality due to crowding and specialist predators. Parameters used for the four aphid species are listed in Table 8.

$$m = Sa(1 + k * x(t - 4))^{-1} \quad (2)$$

m: Delayed density dependent mortality (0-1)

Sa: Density independent survivorship

k: density dependence

x: Aphid density in Aphids/g green biomass at t-4 days

Table 8 Delayed density dependent mortality parameters.

Species	Sa	k
<i>A. fabae</i>	0.9	0.02
<i>A. pisum</i>	0.9	0.012
<i>M. persicae</i>	0.9	0.02
<i>S. avenae</i>	0.9	0.012

2.5.5.3 Reproduction

Aphid fecundity depends on age of the individual, temperature, nutrition, parasitism and size of the aphid (Hagen and Van Den Bosch, 1968, Ratte, 1984, Awmack and Leather, 2002). The effect of parasitism and aphid size is not considered in the model, as individual aphids are not modelled. Winged aphid morphs have been shown to be less fecund than their unwinged counter parts, highlighting the trade-off between dispersal and fecundity in polymorphism in aphids (Wratten, 1977, Braendle et al., 2006, Davis, 1915). Aphids reach their peak fecundity quickly after reaching adulthood. Age-specific survival first decreases after the majority of their fecundity is reached (Bieri et al., 1983) In the model fecundity is influenced by temperature and age of the aphid. For each cell the average daily temperature is used to calculate the relative fecundity (equation 3). For each age group in each cell the set of linear functions presented in Table 9 is used to calculate their potential maximum fecundity. Using the age dependent and relative fecundity the absolute fecundity for each age-group is calculated.

$$FE = -0.006T^2 + 0.264T - 1.93 \quad (3)$$

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Table 9 Aphid age dependent fecundity parameters.

Species	Function	Turning point (DD)
<i>A. pisum</i>	0.1119x+2.9174 0.03322+9.9696	50
<i>A. fabae</i>	0.262x-1.4286 -0.0123x+5.303	25
<i>M. persica</i>	0.1158x-1 -0.0087x+4.5	50
<i>S. avenae</i>	0.0562x+1.1932 -0.0146x+4.6872	50

Data of sexual morph reproduction rates is rare. Markkula (1963) and Davis (1915) reported maximum fecundities of 13.0 eggs/oviparae and 24.8 eggs/oviparae respectively for the pea aphid. Leather (1993) noted that laboratory data obtained most likely is an overestimation of the in-field fecundity and that in effect the average egg production is closer to half the maximum fecundity (Leather, 1993).

2.5.5.4 Movement

Movement can be divided into long distance (flying) and local movement. Local occurs if the local cells population size surpasses that of its surrounding cells, up to 2.5% of the local population being able to disperse

to neighbouring cells per day. The extent of dispersal is dependent on the difference of the population sizes between cells. Long distance movement is undertaken by winged adult morphs for all species.

Winged morphs have a daily chance to fly at a given windspeed and have a set distance they can move (usually long distance). Wind speed is an important fact for flying since aphids are weak fliers that are not able to fly against wind direction when the wind speed is greater than 0.5m/s (Loxdale et al., 1993).

Two polynomial functions are used to generate a long tail landing curve along the wind direction as shown in equation 4.

$$p(l) = \begin{cases} -l^2 + 2d_p l, & \text{if } l \leq d_p \\ \frac{d_p^2(d_l - l)^2}{(d_l - d_p)^2}, & \text{if } l > d_p \text{ and } l \leq d_l \end{cases} \quad (4)$$

Where l is the distance from the landing position to the departure position. In this way, position at d_p will have the largest landing proportion compared to other positions. The flying ones can land at maximum distance of d_l .

After obtaining the landing curve along the wind direction, we need to convert it to a 2D mask in order to land the flying ones on a 2D landscape. Firstly, we rotate the 1D landing curve for 360 degrees through the departure location. Suppose the departure location is at (0,0), the rotation can be done by the equation 5.

$$l = \sqrt{x^2 + y^2} \quad (5)$$

After the rotation, we can get the initial symmetric 2D landing mask to the original departure location using the equation 6.

$$L^i(x, y) = p(\sqrt{x^2 + y^2}) \quad (6)$$

In next step, we need to skew it based on the wind direction. To do this, the cosine value of the angle between the direction from the departure to the destination landing location and the wind direction is used as a weight.

Suppose the wind direction to the departure location is given by $(b, -a)$, the direction from the destination location to the source location is given by $(y, -x)$. Then the weight used to skew the initial landing mask can be calculated by the equation 7.

$$w_c(x, y) = \frac{by + ax}{\sqrt{x^2 + y^2} \sqrt{a^2 + b^2}} \quad (7)$$

Afterwards, the 2D mask with the wind direction of $(b, -a)$ can be calculated by the equation 8, which will be used to the calculation of the landing proportion.

$$L(x, y) = \begin{cases} L^i(x, y)w_c(x, y), & \text{if } w_c(x, y) > 0 \\ 0, & \text{else} \end{cases} \quad (8)$$

When a grid is with winged aphids and the wind speed is below the threshold, the winged aphids will fly to other grids based on the proportion calculated used equation 8. If the landed grid is with host plants, they will start to colony in the new location otherwise they will die.

2.5.5.5 Host

Available habitats assigned in ALMaSS for the four aphid species are presented in Table 10. For primary hosts 20% of green biomass is considered available for the aphids, while secondary hosts use 100%.

Table 10 Key aphid host landscape element and vegetation types

Species	Primary host	Secondary host
<i>A. fabae</i>	Tole_Copse	Tov_Legume
	Tole_ForestAisle	Tov_CerealLegume
	Tole_Scrub	Tov_FodderBeets
	Tole_Hedges	Tov_Legume_Beans Tov_SugarBeet Tov_FieldPeas
<i>A. pisum</i>	Tov_PermanentGrass	Tov_FieldPeas
	Tole_RoadsideSlope	Tov_Legume_Pea
	Tole_RoadsideVerge	Tov_Legume_Whole
	Tole_PermanentSet-aside	Tov_Legume_Beans Tov_CerealLegume
<i>M. persicae</i>	Tole_Copse	Tov_Legume_Beans
	Tole_ForestAisle	Tov_Potato
	Tole_Scrub	Tov_Carrots
	Tole_Hedges	Tov_Cabbages Tov_SugarBeets Tov_LegumePeas
<i>S. avenae</i>	Tov_PermanentGrass	Tov_WinterWheat
	Tole_RoadsideSlope	Tov_SpringWheat
	Tole_RoadsideVerge	Tov_SpringBarley
	Tole_PermanentSet-aside	Tov_WinterBarley

2.5.6 Red mason bee (*Osmia bicornis*)

O. bicornis was selected for modelling as a representative of solitary bees and effective springtime pollinators of crops and wild plants. *Osmia* spp. are one of the best known among solitary bees and are reared on commercial scale to be used as managed alternative pollinators. The ALMaSS red mason bee model was developed within the project “Beneficial insects in agricultural landscape: modelling effect of pesticides and landscape structure” founded by the National Science Centre, Poland (project no. 2015/19/B/NZ8/01939) and finalised within the EcoStack project. The assumptions and description of the model have been presented in the Formal Model (Ziółkowska et al., 2023).

The model simulates both the position of a bee and its nest on a daily basis. The bees are categorized into six life stages: egg, larva, prepupa, pupa, cocooned adult, and adult. The development of the red mason bee is similar to that of other spring species of the *Osmia* genus. Life stages from egg to cocooned adult occur inside the nest (Figure 23) and are modelled according to the in-nest life-stage state machine and transition path (Figure 24). Egg laying and larval development occur in spring, while prepupal and pupal stages occur in summer. The imago instar appears in the cocoon at the end of summer/beginning of autumn. In the model, the duration of in-nest development is temperature driven, such that higher temperatures lead to faster development of eggs, larvae and pupae. The relationship between the duration of the prepupal stage and temperature is non-linear, i.e., the highest prepupal developmental rates are attained at intermediate temperatures and is therefore implemented using a quadratic function. According to many authors, duration of the prepupal

diapause is the main mechanism through which populations of *Osmia* spp. from different geographical areas synchronize adult eclosion with local temperature declines in the autumn.

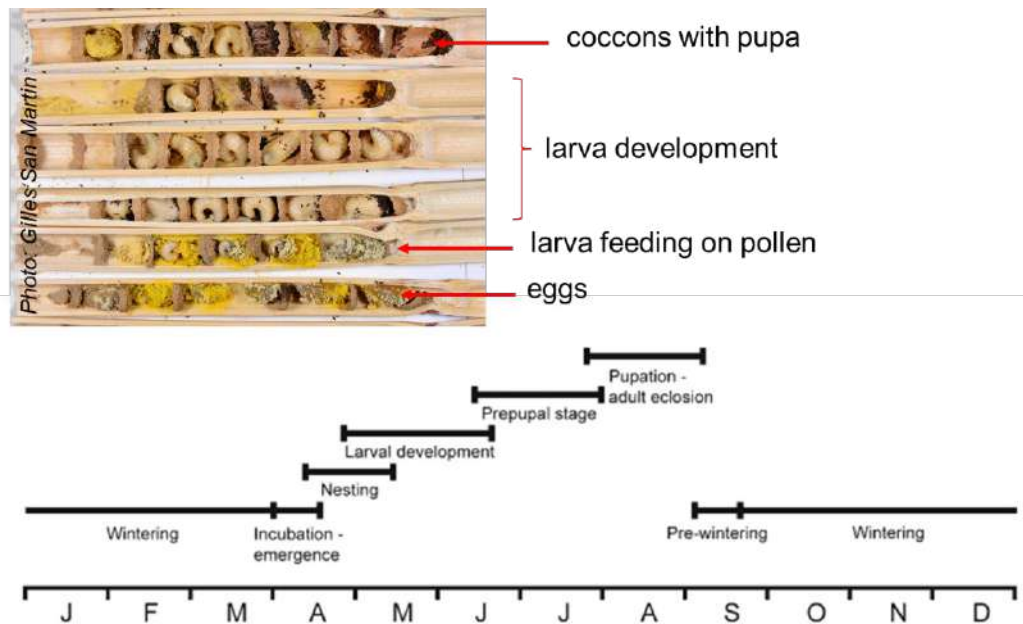


Figure 23 Red mason bee developmental cycle for central European populations (based on Sedivy and Dorn (2014))

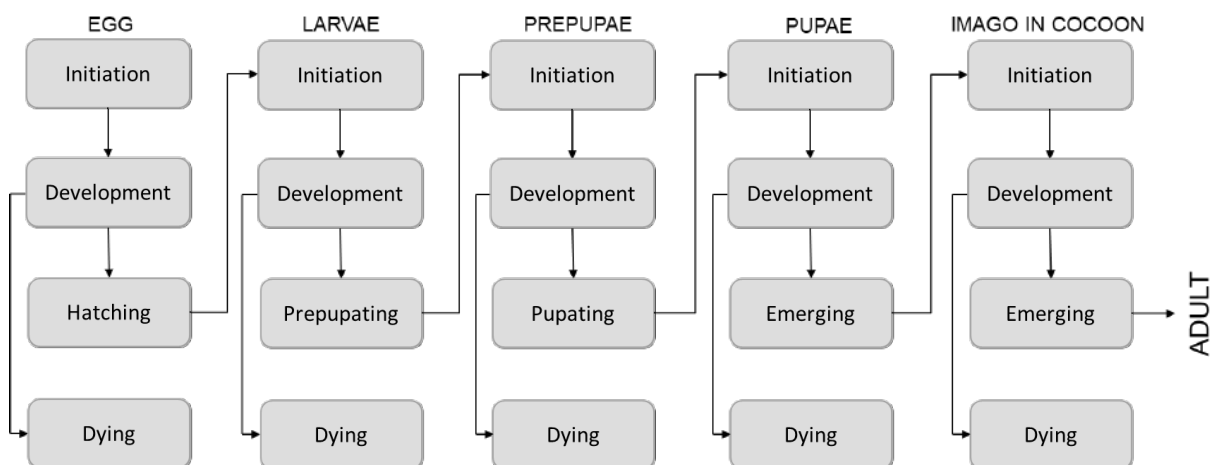


Figure 24 Red mason bee (*O. bicornis*) state diagram showing development within the nest.

The cocooned adult is the overwintering form of the red mason bee. The overwintering period is divided into three parts: pre-wintering, diapause, and post-diapause quiescence. In the model, temperature conditions during the pre-wintering period, defined as the period from the end of the pupal stage to the onset of winter temperatures (i.e. a sudden drop in temperature below 15°C followed by 5 days of sufficiently low temperatures), influence the overwintering mortality of the bee, so that the warmer the pre-wintering period, the higher the mortality. On the other hand, temperature conditions during diapause influence the timing of bee's emergence from the nest in spring, such that the warmer the winter, the earlier the emergence.

Adult bees emerge from the cocoons and leave the nest in spring to interact with the local landscape/environment. Only females are included in the model as the role of males is limited to insemination and we assume that all the females are fertilized. After a short period of pre-nesting (i.e., time spent on feeding

and completing ovary maturation), females begin to move around the landscape in search of nesting sites and food resources to provide pollen for their offspring. Although in reality provisions could contain a small amount of nectar, for the purposes of our model we assume that nectar is not a limiting factor, hence only pollen resources and the search for pollen are considered.

The red mason bee accepts various pre-existing cavities as nest sites, usually tube-shaped; thus, in the model the nest is defined as a linear structure with a suitable diameter to allow the construction of *O. bicornis* cells. Over the course of a lifetime, females construct several linear nests in succession; cell by cell in linear order separated by mud partitions. In the model, the reproductive potential of the female is characterized as the total number of eggs she can produce in her lifetime (a property given to an adult female after emergence) and depends on the bee mass. In the model, each bee has an initial 'plan' for a nest to build a given number of cells with a given sex ratio (based on the bee's age and mass), with a planned (or target) cocoon mass for each cell in the nest. Then, given the target cocoon mass, the amount of provision required for each cell in a nest is calculated. Importantly, due to landscape (pollen resource availability), weather conditions and other factors (e.g. bee death or nest abandonment), the execution of the provisioning plan by a bee is not guaranteed. Thus, during the simulation, fewer brood cells may be provided than planned, the sex of the egg may be changed if provisioning is too low, and the total number of planned eggs per nest may be reduced if conditions are unfavourable (pollen resources around the nest are scarce or weather conditions are poor for a prolonged period).

In the model, bees can die because they have finished laying all their planned eggs, because they have reached the end of their life span or because of external events. Mortality due to external, unknown factors is defined separately for the egg-to-pupa stage, overwintering and adult bees outside the nest (background mortality).

O. bicornis populations depend on both nesting and foraging habitats. In the model, nesting density is provided as the number of nests available per 1 m² of each landscape element in the land cover map. The possible minimum and maximum nesting densities per landscape element type were defined based on literature data (Koh et al., 2015). Thanks to the floral resource models which are incorporated in the ALMaSS landscape model, a bee is able to sample the landscape on each day of the simulation to obtain information on the amount of pollen produced in a given resource patch (in mg per m²). In the model, bees are able to explore the area around the nest. The implemented search algorithm ensures that the probability of encountering a patch of pollen decreases with distance from the nest, and the probability of encounters near the nest is very high, which corresponds to the *Osmia* behaviour observed in the field.

The ALMaSS red mason bee model was evaluated against the literature and field data in terms of (1) time for in-nest development for all stages, (2) adult flight phenology, (3) distribution of eggs per nest, and (4) emergence weight of female *Osmia* adults. Further, the model parameters were adapted to all the simulated countries. Modelled species phenology is shown in Figure 25.

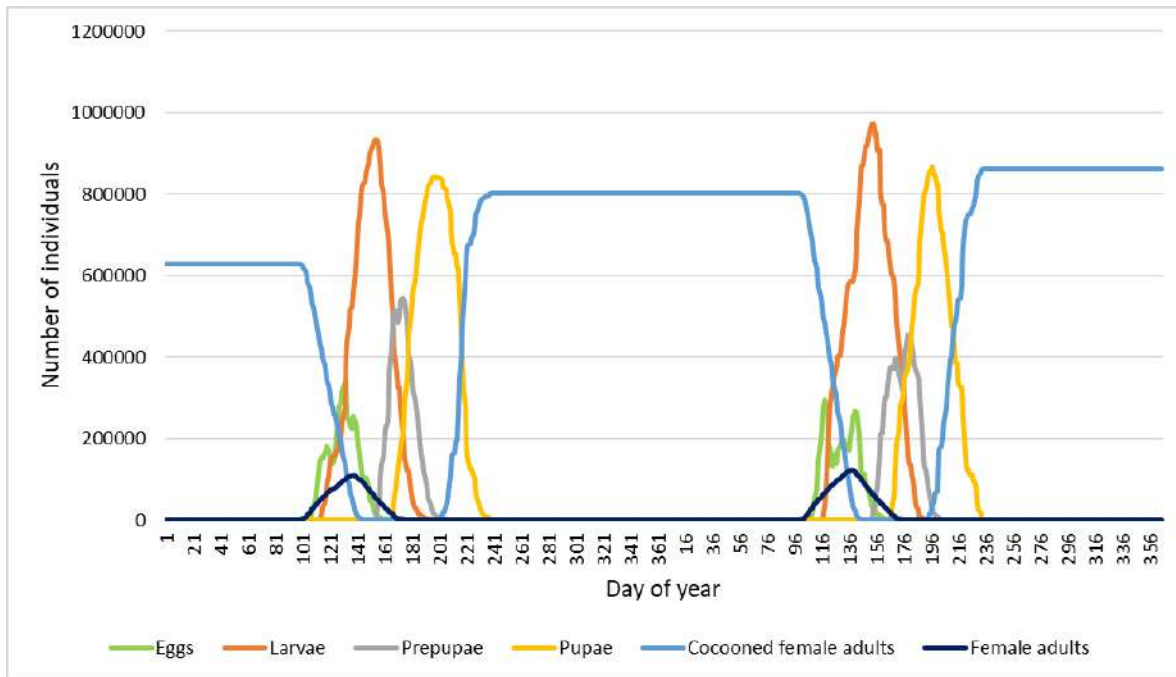


Figure 25 Two years of phenology of modelled *Osmia bicornis* under Polish weather conditions.

2.5.7 Eurasian skylark (*Alauda arvensis*)

The skylark is an excellent example of a farmland bird species which has undergone widespread declines, is subject to conservation management plans, and for which the drivers of decline are complex (European Communities, 2007). The skylark is generally viewed as typifying farmland birds nesting in fields and is often used as an example in pesticide risk assessment. The ALMaSS skylark model was described by (Topping et al., 2013, Topping and Odderskaer, 2004) and documentation can be found on: <https://almassdocs.au.dk/ALMaSSODdox/Skylark/index.html>.

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In the model, individual modelled skylarks are categorised into five distinct life stages: clutch, nestlings, pre-fledglings, males, and females. The primary determinants within the skylark model include the topography and habitat quality of the landscape elements under consideration, farming activities (including crop selection and physical disturbance), crop growth, and prevailing weather conditions.

The availability of insect food biomass is contingent upon the vegetation structure within each landscape element and type and its physical accessibility to the birds. This parameter is updated daily within the model. During the defined breeding period encompassing incubation and care of young up to 30 days old, the model accounts for the energetic balance of adults, the food requirements for maintenance, the needs of the young, and the impact of weather constraints. Weather serves as both a limit to foraging success and as an additional energetic cost during cold conditions.

The initiation of breeding is contingent upon the discovery of a suitable territory and, subsequently, the identification of vegetation structure suitable for a nest site. Breeding success hinges upon the habitat's ability to meet the energetic requirements of the birds throughout the breeding period and ensure the survival of eggs and nestlings. Instances of disturbance during nesting, such as farming activities, are infrequent during the breeding season, but if they occur will directly impact the nest. This also means that early or late nesting or unusually time farm management, can subject the skylarks to disruption of breeding.

The original skylark model was calibrated to an extensive set of data from Denmark (Topping et al., 2013) and thus it was not expected that the default parameters could be used to represent skylarks in other countries,

and time periods. Since this time the Danish population has declined, and a recalibration was needed. This was not done in the same way for all countries due to differing climates. The changes made are described under Section 4.3 (Local adaptation of species models).

2.5.8 Field vole (*Microtus agrestis*)

The field vole (*Microtus agrestis*), also known as the meadow vole, is a small, semi-fossorial rodent with a broad distribution across Europe, Asia, and North Africa. They inhabit a variety of habitats, including grasslands, meadows, farmlands, and even urban areas. Their adaptability and high reproductive rates make them abundant in suitable habitat types. They are primarily grassland specialists, preferring open areas. They are particularly attracted to meadows, set-aside land, flower strips, and grassy field verges. They often construct shallow burrows with simple tunnel networks, with entrances located near feeding areas. Its primary food source is grasses, but it also feeds on a variety of other plants, including clover, alfalfa, and even garden vegetables. Field voles exhibit remarkable reproductive rates, capable of producing multiple litters throughout the year. In favourable conditions, females can produce up to 10 litters per year, with an average of 5 to 6 young per litter. This high reproductive potential contributes to the species' abundance and ability to rebound from population crashes. Field vole populations exhibit cyclical patterns, experiencing periods of high abundance followed by crash phases. These cycles are thought to be driven by a combination of factors, including resource availability, predation pressure, and weather conditions (Hendrichsen et al., 2009). The degree of cycling is one interesting emergent property of the model used.

The original vole model was described by Topping et al. (2003a), and revised by Topping et al. (2012). Documentation for the field vole model can be found at:

<https://projects.au.dk/fileadmin/dmu.dk/en/animalsplants/almass/ALMaSS/Vole/index.html>. The model was not altered for EcoStack, except to bring it up to date with all habitats and crops required to work in all six EcoStack countries.

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The ALMaSS field vole model simulates individual field voles as agents representing three life stages: juveniles, adult females, and adult males. During their life cycles, voles engage in a number of behaviours based on information obtained from their local environments and conspecifics. Voles enter the simulation at the location of their mother's nest at day 14, where they were weaned. They enter the simulation as either females or males, assuming an even sex ratio, and immediately begin searching for suitable territories. Voles don't deplete food resources in the landscape, preventing bottom-up regulation by food availability; however, density-dependence is incorporated through local competition for territories (both sexes).

Each day in the simulation, voles begin by assessing their local environments or territories. Other behaviours follow based on the information gained during this process. Voles need to have territories to breed. Males can mate with females if their territories overlap with the position of the females. In cases where several males have overlapping territories with females, females choose the males closest to them. Young voles that find themselves in the territories of older voles with more than 50% overlap are forced to move. The criteria used to assess the quality of territories varied with the season and included the presence of mature females for mature males during the breeding season.

The start of the breeding season is determined by the appearance of new green grass growth, which has been controlled by ALMaSS vegetation. This is currently the only weather/vole interaction included in the model. Mortality is modelled as the result of predation, starvation, if voles spend too much time in unsuitable habitat, or by reaching their physiological lifespan limit of 15 ± 3 months. Mortality also included infanticide attempts by mature males moving outside their original territories and encountering females with unweaned young.

2.5.9 European hare (*Lepus europaeus*)

The hare model employed in the EcoStack simulations was the European Brown Hare model, as detailed by Topping et al. (2010). This model replicates the growth, movement, reproduction, and mortality of individual hares, utilizing a daily time-step for most activities and a 1-minute time-step for foraging. A comprehensive documentation of the hare model can be found at:

<https://projects.au.dk/fileadmin/dmu.dk/en/animalsplants/almass/ALMaSS/Hare/index.html>.

The hare model encompasses five life-stages: infants up to 11 days, during which they rely entirely on the lactating doe; young hares aged 12–35 days, after which they are fully weaned; juveniles aged 35–365 days; and adult males and females. The model portrays hares as highly mobile animals capable of locating suitable forage across broad areas when not burdened with young. Under favourable feeding conditions, hares tend to cover large territories, while in adverse conditions, they optimally forage and may consequently confine themselves to localized ranges for specific periods within a season. This behaviour is emergent from the foraging rules in the model.

Breeding initiates in spring if the body condition permits the production of foetal mass. Following birth, the female must augment her energy intake to provide sufficient energy for lactation. Energy is derived from foraging on green shoot material, with the amount obtained contingent on the shoot's age and the overall structure of the vegetation. Dense vegetation, although rich in biomass, may exhibit poor digestibility and high impedance. A female unable to sustain lactation due to insufficient combined energy intake and reserves will abandon her young. Reproduction is then deferred until energy reserves are replenished.

The growth of model hares is also contingent on energy balance, and those failing to achieve 45% of their potential weight at any age will succumb. Adults seldom perish due to energy scarcity and are assumed to tolerate a negative energy balance, persisting in the population and contributing to social stress - an essential density-dependent regulatory factor in the hare model that curtails population growth. Hunting, if assumed, takes place in autumn, while other non-energetic losses are determined by life-stage specific constant daily probabilities (e.g., predation of young) or events triggered by human management activities (e.g., harvest mortality).

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2.6 Code adaptation for parallel processing

During 2023 it became apparent that the speed of the model's execution was going to significantly restrict the number of scenarios possible. To ameliorate this problem the arthropod models were all rewritten to make use of parallel processing using a multi-threaded library.

In the original ALMaSS design, the population manager held all individuals in agent-based models in a data structure with a variable number of entries, one for each life stage represented as a separate class in the model. This means that this data structure must be traversed serially in scheduling and other operations, and for simulations with many organisms, this is inefficient. However, a relatively easy option exists for managing these lists in parallel with modern CPUs and code libraries. This option is now implemented in the current version of the population manager code and the species code is also adjusted to use parallel processing for all arthropod models.

Instead of having a single list for each object type, the list of objects is now created as a set of lists, one for each thread. These are denoted as "TheSubArrays" within the program code. "TheSubArrays" is a vector of vectors of forward_list. Vectors are arrays that can change in size during run time and are randomly accessed, thereby allowing the number of lists to be altered at run time to match the number of threads. A forward_list is a C++ container for a singly linked list (each object points to the next), which is an efficient way to manage a list of objects that can be added to by pushing objects onto the end of the list. These two flexible structures mean

that the size of the population can be determined at run-time and can be easily manipulated by descendant classes.

The first dimension of "TheSubArrays" represents the types of population entities managed by the population manager, typically the life stages of the modelled organism. This approach allows descendant classes to change the number of life stages modelled by changing the first dimension. The second dimension of "TheSubArrays" is the thread number, enabling parallel running when more than one thread is used. If only a single thread is used, the simulation is run sequentially. Thread-based parallel computing was implemented using OpenMP (Chandra, 2001). The third dimension of "TheSubArrays" is the list of individuals at each life stage manipulated by each thread. The length of this list will change with time during the simulation as individuals die or are born.

Several agents in the same life stage run simultaneously when the individuals are looped inside the three-step methods; this is the critical procedure to accelerate the simulation running. However, this can cause problems when more than one individual access the same resources. The issue here is the simultaneous use of a resource by multiple agents. In this case, both may assume that they obtain it. These situations would result in serious program bugs and be challenging to track. To avoid this, we introduce a 'guard map' for the landscape by segmenting the landscape into non-overlapping grids. Each grid has a 'guard flag' to ensure that only one individual can perform location-related activities in a single grid. Before an individual tries to perform an activity in a specific location, it must possess the guard flag for that location. This guard flag stops other agents from carrying out behaviour here, and once the behaviour is completed, the flag is released.

Below we illustrate the impact of varying thread counts on the execution time using a simple toy model called Theoretical2. The Theoretical2 example involves the creation of 10,000 animal objects. Each time step, the population experiences 1040 new-born animals with 1000 dead animals, resulting in a gradually expanding population. Each animal is composed of a data structure containing 1,000 real number values. Within the timestep function, 10,000 square calculations are performed for each animal, and no other functionalities are associated with Theoretical2 animals. All the simulations were run using the same ten by ten km landscape, and each run had a duration of 5 years. The ALMaSS simulations require the landscape, but in this simple example, the landscape does not affect the difference in the run time since Theoretical2 doesn't interact with it. The run time depends entirely on the number of threads and the population size. The run time for different thread counts is presented in Table 11. Employing multithreading yields a notable reduction in run time, with an improvement of 63% when using five threads. Leveraging more threads further accelerates the processing speed, although the rate of improvement gradually diminishes.

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Table 11 Run time with different thread number for the Theoretical2 model.

Number of threads	Running time (seconds)	Relative to running time with 1 thread
1	443	1.00
5	164	0.37
10	129	0.29
20	112	0.25
40	103	0.23

None of the species in ALMaSS originally supported parallel processing. To handle the large number of simulations, we adapted the species code for *E. astra*, *O. fuscus*, *B. lampros*, *C. septempunctata*, *O. bicornis*, and

all four aphid species using the previously described method to enable parallel execution. This adaptation significantly reduces simulation runtime by utilizing the many CPU cores available on supercomputing centres. For example, before the adaptation, a 10-year simulation of *E. atra* in a 10km by 10km Polish landscape took approximately 68 minutes. After the adaptation, this was reduced to about 18 minutes using 10 CPU cores on a standard desktop computer.

2.7 Simulation Set-up

Simulations were run using storage and high-performance computing (HPC) partly supported by HPC centres, Ucloud, LUMI and GenomeDK (GenomeDK, 2024), through the DeIC (DeiC, 2024) National HPC (g.a. DeiC-AU-N1-000025, DeiC-AU-N2-2023015 and DeiC-AU-L5-0011) in Denmark. The data were divided into inputs, outputs and a run directory containing the necessary system files for each species to run ALMaSS, as shown in Figure 26. Inputs included four versions of landscape files: baselines (10 landscapes in each of six countries) and additionally three versions of artificially manipulated landscapes by including in-field margins of three different widths (2, 4 and 8 m). The type of field margins added to the landscape was subsequently modified through the polyref files by changing the vegetation type from flower mixture to grass (see details in ALMaSS Outputs for analysis).

Inputs further included rotations for seven distinct scenarios for all countries, weather data for individual landscapes within a country, and vegetation curves. Outputs included daily population counts (number of individuals at each life stage), as well as cell occupancy (proportion of grid cells in the landscape with adult individuals or super-individuals present) and abundance (number of adult individuals or super-individuals in the occupied cells) calculated for cell sizes of 50m, 100m, 200m and 400m. The latter two endpoints can be presented as Abundance-Occupancy Relationship (AOR) plots (Høye et al., 2012). For aphids, the outputs also included daily population counts not only for the whole landscape, but also exclusively for managed fields.

Configuration files were generated for individual simulation replicates, totalling 66,000 files excluding stacking scenarios and output files were stored separately for individual species in each country and for separate scenarios. Species starting conditions can be found in Table 12. To manage the huge number of files, scripts were created in Visual Studio Code ver. 1.85.1 (Microsoft, 2024) using Python ver. 3.9.12 (Van Rossum and Drake, 2009). All simulations were submitted to the HPCs using bash scripts specifying species-specific memory and computational resource requirements (run time, nodes and CPUs).

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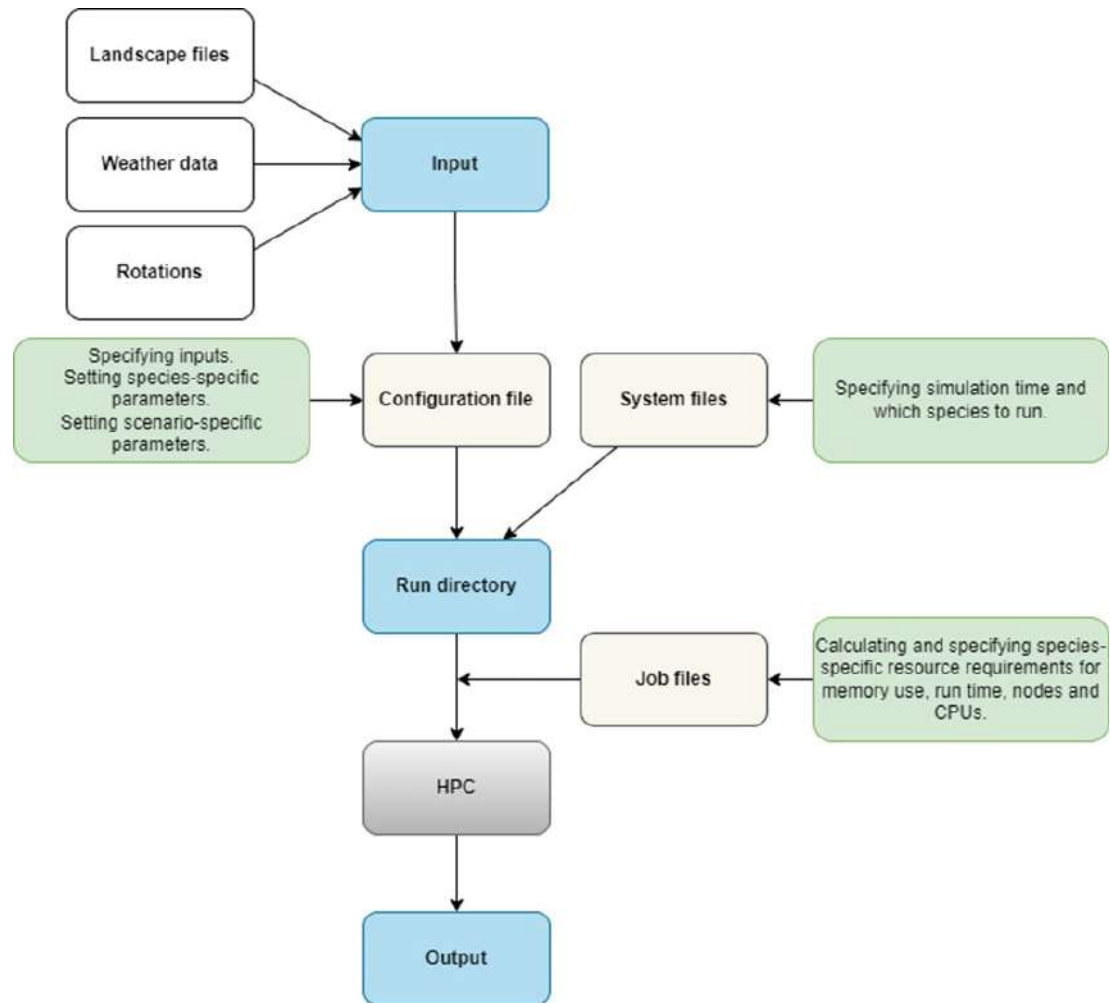


Figure 26 Flowchart illustrating the workflow of running ALMaSS simulations using HPC from input to output. Blue: folders, beige: files, white: ALMaSS inputs, green: process.

Table 12 Starting conditions for individual species.

Species	Number of individual / super-individuals at the simulation start	Number of simulation years
Ground beetle (<i>B. lampros</i>)	200,000	30
Ladybird (<i>C. septempunctata</i>)	25,000	20
Aphids (<i>A. fabae</i> , <i>A. pisum</i> , <i>M. persicae</i> and <i>S. avenae</i>)	20,000 eggs/100m ² suitable area (pea and grain aphids), 10,000 eggs/100m ² suitable area (peach and black bean aphids)	20
Dwarf spider 1 (<i>E. atra</i>)	100,000	30
Dwarf spider 2 (<i>O. fuscus</i>)	50,000	30
Red mason bee (<i>O. bicornis</i>)	50,000	30
European hare (<i>L. europaeus</i>)	1000 males and 1000 females	30
Eurasian skylark (<i>A. arvensis</i>)	10,000 males and 10,000 females	30
Field vole (<i>M. agrestis</i>)	20,000 males and 20,000 females	30

2.8 ALMaSS Outputs for analysis

ALMaSS is capable of providing very detailed outputs, many of which are tailored for each species. However, for our analyses comparing across all species and countries, we needed a common set of outputs which could be directly compared. Two main outputs were used. The first is a simple time series of all life-stages showing the number of individuals in the entire landscaper per day. The second is a record of the population of individuals through time and space the AOR-index an abundance–occupancy relationship (Høye et al., 2012). This second metric is recorded once per year and shows the number of individuals in the landscape but divided into squares to represent distribution in space. The size of the squares differs between species and is determined from the baseline such that as close as possible to 50% of the squares are occupied. Although this must be done within the limits of minimum and maximum sizes of 50m and 500m respectively. See Table 12 for the size of the squares.

For aphids, the population measures were also created for the aphid populations occurring within the fields to allow for an estimation of the impact on aphid control.

In all but the aphid/ladybird scenarios the simulations were run for 30 years, and the last 10 years used to generate the statistics. This allows for a ‘burn-in’ period and is standard practice for ALMaSS studies and is based on a safe margin for stabilisation or the population without driving populations to extinction in the case of declining population situations. For the aphid/ladybird scenarios, since these were computationally much heavier (5 species run together), we found that we could generate reliable results from 20 year runs and using the last 10 years (saving considerable CPU hours).

2.9 Scenarios

2.9.1 Baseline

The baseline scenarios in all cases represent the current situation with the landscape structure and farm management derived from the landscape generation process (see Landscape Generation Overview section). The baseline ALMaSS landscape model represents the topography with farmed areas associated with the crop rotations and pesticide use, as reported by farmer advisors when crop management plans were compiled for different crops. This baseline is the starting point for all scenarios that modify one or more aspects to determine the effect on animal populations. Each scenario run therefore represents a particular 10x10km landscape as modelled in the landscape generation. This means that we do not morph the landscape over time as the scenario runs but fix it and look at the long-term consequences of the baseline compared to the scenario.

All farm activities, such as pesticide use and soil cultivation, have an impact in the ALMaSS model. Pesticides are modelled as an instantaneous mortality applied to individuals present at the site at the time of pesticide application. Similarly, vegetation clearing, ploughing and other destructive actions cause mortality. These actions also have indirect effects by altering vegetation structure, which may alter animal behaviour (e.g. destroying skylark nests or increasing the attractiveness of a particular habitat patch for nesting). Therefore, the scenario changes to the baseline described below can have direct and indirect effects on animal populations by changing habitat characteristics in a way that is very similar to what occurs in real systems.

2.9.2 Field margins

Two types of field margins, grass and flower, were added along field edges, also between adjacent fields, to the baseline landscapes. They were added to 100% of the fields larger than 1Ha as either single managements (100% *grass* or 100% *flower*) or in combination were both were added equally (*mixed*; 50% of each). They were further added at three different widths: 2, 4 and 8m, totalling 9 versions of the same landscape. The flowers and grass differed in their nectar and pollen availability for *Osmia* and also in their cutting regime, with mown grass cut at the beginning of May and the middle of September and flower strips cut between the end of August and end of October.

2.9.3 Set-aside and legume

Legume and set-aside were implemented as two separate scenarios by addition to baseline rotations. They were added in 4, 7 and 10% for all farms by area. To implement these scenarios extra legume or rotational set-aside crops were added to all farm rotation files for each country. These effectively increased the number of entries to the rotation files (see Table 1) and inserted the relevant number of new entries in agronomically sensible locations. Legumes added were each country equivalent of a field beans crop, whereas set-aside was added an annual set-aside crop. The levels of 4, 7 & 10% were chosen to represent current legal minimums and two higher optimistic levels of coverage. When seen from the perspective of the total area under crops in a landscape this method accurately represents the additional areas. However, it is important to note that this in effect reduces all other crops pro rata. Thus, the choice of which crops to replace with set-aside or legumes is passive, and effectively they replace the most common crops most. This has consequences for interpreting the scenario results since the crops replaced are important for the effect, not only the crops added.

2.9.4 Crop diversification

Similar to set-aside and legume scenarios, the crop diversification scenario was implemented by manipulation of farm rotation files. It was implemented by removing the top 20% of most represented crops and increasing, with the same percentage (20%), the least represented crops for a more even distribution of crop types represented in the landscape.

The diversification scenario rotations are based on conventional baseline rotations. For each conventional baseline rotation, the crop type(s) that are proportionally the most frequently cultivated in a 100-year rotation added up until 50% (e.g., 30% winter wheat and 20% spring barley) are reduced by 20% in the 100 year-frequency (e.g., reduction to 24% winter wheat and 16% spring barley = 30% of all crops). The crop types that are smaller in proportion (e.g., 5% winter barley, 5% grazed clover grass 10% spring wheat, 15% winter rye, 15% maize for silage), are increased by 20% (e.g., 7% winter barley, 7% grazed clover grass 14% spring wheat, 21% winter rye, 21% maize for silage = 70% of all crops).

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This way, we create scenarios with a higher diversification because the proportion of crops in the rotation are more even, and therefore the 100-year rotation is more diverse (fewer years with the same crop type in a row with few years between) than in the baseline - though it is the same crop types (no new types are introduced).

2.9.5 Biopesticides

It was assumed that biopesticides are equally as effective as chemical plant protection products (PPPs) for targeted organisms and that they have no adverse effects on beneficial organisms. In this scenario, the effects of biopesticides on pest species have the same level of control. Therefore, all biopesticides have the same effects on the four aphid species as the normal pesticide does. However, all biopesticide effects on non-targeted animals (NTAs: skylark, hare, ground beetle (*B. lampros*), spiders (*E. atra* and *O. fuscus*), ladybird (*C. septempunctata*), field vole, red mason bee) are reduced. Biopesticides were thus constructed to reduce the lethal impact on NTAs by 100%, 95%, 90%, and 80%, where 100% is equivalent to no lethality. If X% denotes the chemical impact on the pest, and mortality for NTAs is given by Y% of the current chemical impacts (where a value of 100 in both cases means that they are equivalent to using the current chemical approaches, while 0 means no mortality), the X;Y pair for the biopesticide scenarios will be (100;0), (100;5), (100;10), (100;20). They were applied to three crops: winter wheat, oilseed rape, and potatoes, while other crops received regular pesticides.

Insects are the main food source for skylark and spiders (*E. atra* and *O. fuscus*). We assume the insects for skylark are mainly from the NTAs. Thus, all the biopesticides will increase the insects for skylark, with the most significant increase at 100% and the least at 80% compared to the normal pesticide. But for the two spiders, their food source can come from both NTAs and the targeted pests, and therefore we have different settings

for the biopesticides on the insects as food for the two spiders. They will have the same insects with 100% compared to the normal pesticide. The amount of food for the two spiders will decrease as the reduction decreases, thus 80% will have the least amount of insects for the two spiders.

2.10 Analysis - comparing scenarios

All analysis used either Python 3 (Van Rossum and Drake, 2009) or R version 4.2.1 (R. Core Team, 2022). There are two divisions in the objectives of the species level analysis. For the beneficial farmland species (beetles, spiders, and bees) and the vertebrate species (hares, voles, and skylarks), the objective is to maximise population levels. For the pest management species modelling, which includes the four aphid species and their main controlling predator the ladybird the objective is to minimise the crop damaging effect of the aphids. With this in mind, for the species maximising populations, we record the population of individuals through time and the AOR-index an abundance–occupancy relationship (Høye et al., 2012). For the pest-management species however, we are interested in reducing the aphid density, as this directly relates to the damage the aphids' cause. To enable a more detailed look at this, aphids were also measured as the sum of aphids in farmers' fields, as well as for the entire landscape.

In both cases we are interested in the relative change of the scenarios to the baseline scenario, but it is important to consider the level of the baseline population. For example, a 200% increase in a population of 200,000 individuals is different than a 200% increase from a population of 5. We therefore give the relative change and the baseline population levels. When calculating relative change, we propagate the uncertainty combining the variance of the baseline and the scenario in question using the R package "pairwiseCI" (Schaarschmidt and Gerhard, 2019) and the MOVER-R method (Donner and Zou, 2012)

The analysis takes place at a countrywide level, pooling the individual repetitions on each of the ten representative landscapes. We initially consider each species individually and seek to explain why each scenario has that particular effect on landscapes with different characteristics. We will then do a multi-criteria analysis weighting the scenarios for each species to try and predict how best to stack scenarios.

With enough different species modelled each species could be individually weighted. But in our case, we have differing numbers of species that are representative of different ecosystem functions. *Osmia* representing pollinator functions, four species, the two carabids and the two spiders representing predatory invertebrates, and the aphids collectively representing the effect of ladybird control of pests. We additionally have three vertebrate species to represent vertebrate biodiversity. With this in mind, we propose weighting these groups by one over the number of species in each group. This reduces the weight of the predatory insects. Aphids were further multiplied by -1 to invert the effect as the goal was to reduce aphid numbers.

2.11 Multi-criteria analysis and maximum uptake stacking scenarios

A multi-criteria analysis is a means of evaluating multiple or conflicting criteria. In our case, we wanted to assess which measures would have the greatest impact on supporting ESP populations in agricultural landscapes across the EU, thereby improving pest control and pollination services. Each species may respond differently to scenarios, and a scenario that benefits one or a few species may have no effect or a negative effect on other species. The scenarios also come at a cost. Implementing the scenario means that a certain area of land will have to be withdrawn from agricultural use or the way it is managed will have to be changed. This could result in a loss of yield and income.

We did not perform a multi-criteria analysis of the results per se. Rather, we proposed five different weighting schemes that can be applied to our results in order to drive the decision-making process of selecting the best performing measures. This was an important intermediate step in defining the maximum uptake stacking scenarios. These maximum uptake stacking scenarios may be considered as 'maximum-uptake' scenarios, as here we assume that farmers would be willing to do the maximum possible to support ESP in agricultural

landscapes. However, expert analysis and opinion on likely uptake by farmers were then used to revise the maximum uptake stacking scenarios and to define 'restricted uptake' scenario. This is covered in the Deliverable D9.2 'Simulation of policy options uptake'.

In the proposed schemes, weighting was always applied to the relative changes in species numbers resulting from the application of a given measure compared to the species- and measure-specific baseline scenarios. Relative changes in aphid populations were inverted in the weighting process (i.e., the greater the reduction in aphid numbers, the better) so that they could be compared with results for beneficial species. In addition, we did not include ladybirds in the weighting process as they acted on the aphids.

The five proposed weighting schemes were defined as follows. The first, 'unweighted', was calculated by averaging all relative changes across species (weighted equally), landscapes and countries for each individual measure. In the second weighting scheme ('arable'), these averaged relative changes were scaled by an implementation cost (i.e., the cost incurred by the farmer during the implementation of the measure). Thus, this weighting scheme shows how costs could be included if we could determine the trade-off between score and cost. As it was not possible to use the true costs of implementing measures (given the complexity of true costs estimation for each farm and country), we made a simple assumption that the implementation cost is proportional to the area of land changed by the introduction of a given measure. Thus, in this weighting scheme, the relative changes in species numbers were multiplied by one minus the relative change in arable area (occurred due to application of a given measure). At this stage the area could have had a true cost associated with area being taken out of production or could have included costs of covering an area in biopesticides for example, but in our example we did not.

The next two weighting schemes ('arable invertebrate' and 'arable vertebrate') were similar to the 'arable' scheme but calculated separately for invertebrates and vertebrates. Finally, the fifth weighting scheme used the same method as 'arable invertebrates', but instead of weighting species equally, the ecosystem services (pest control and pollination) provided by the analysed invertebrates were weighted equally. This means that the scaled relative changes in species numbers for all species providing either pest control or pollination services were summed and divided by the number of species in each category. Thus, the results for two spiders, ground beetles, and aphids were summed and divided by four. This weighting scheme represents an arable area cost-benefit estimate equally promoting pest-control and pollination services.

We therefore presented five different options for the multi-criteria analysis. An unweighted effect of the scenarios where all species are treated equally and there is no cost of implementing the scenario. An arable weighted scenario, multiplying by the percentage arable land remaining. A scenario with only the vertebrates treated equally, with the arable weighting. A scenario with only the invertebrates treated equally, with the arable weighting. And finally, only the invertebrates were considered, but this time with the goal of pest management given equal weighting to that of pollinator services by having the beetle, spiders and aphids a lesser weight so that collectively they are as important as the solitary bee.

All five weighting schemes were collectively considered to select the best-performing measures for the stacking scenarios. Once this was done, combining measures into a single simulation run within ALMaSS was relatively straightforward.

Stacked scenarios have been run in the same landscapes and therefore may have less predictable results. There may be little to gain by adding a scenario if a single scenario already maximizes a species response to a crop, for example. Because these are complex models, it is also possible that species may benefit from one measure in a stacked scenario and collectively lose out on another important component. If the measures build on each other, the stacked scenarios also have the potential to have a multiplicative rather than an additive effect. The

efficiency of stacked scenarios was measured by comparing the stacked scenarios to their component scenarios in terms of both changes in absolute species numbers and relative to the baseline.

3 RESULTS

Individual based simulations were run for the red mason bee (*Osmia bicornis*), ground beetle (*Bembidion lampros*), spiders (*Erigone atra* and *Europaes fuscus*), European hare (*Lepus europaeus*), field vole (*Microtus agrestis*) and Eurasian skylark (*Alauda arvensis*), and predator-prey system by combining the ladybird (*Coccinella septempunctata*) individual based simulation with four sub-population models of aphids (*Aphis fabae*, *Acyrtosiphon pisum*, *Myzus persicae* and *Sitobion avenae*). The baseline scenarios were run for all species for each of the 10 landscapes in Denmark, Germany, Poland, Netherlands, Finland, and France. The diversification scenario was first run for the set of landscapes in Denmark and Germany. After that, it was decided that this scenario would not be analysed in the other countries due to its low impact on the modelled species and high cost of setting-up. Other non-baseline scenarios for *B. lampros*, *O. fuscus* and *E. atra* were only run for the set of landscapes from Denmark, Germany and Poland as these models were computing resource intensive. For vertebrates (*L. europaeus*, *M. agrestis* and *A. arvensis*) and *O. bicornis*, non-baseline scenarios (except the previously mentioned diversification scenario) were run for each of the 10 landscapes in all countries. As simulations for the predator-prey system required running five species simultaneously (the ladybird and four aphids), they were the most computing resource intensive, and thus were possible to run only in limited number of landscapes, i.e., in Denmark and Germany. An overview of which countries were run for different species and scenarios can be found in Table 13.

Effects of single measures were then combined across species, landscapes and countries and analysed using the multi-criteria decision-making approach. This allowed us to select the most beneficial measures from the point of view of all analysed ESP, which were then combined in so-called maximum uptake stacking scenarios. These stacking scenarios were run across all species for each of the 10 landscapes in all countries.

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In total over nine million CPU hours were used to run the scenarios. For a scale comparison, it would run up to 65 years if one single computer with 16 CPU cores was used to run the simulations. This generated 1.20 TB of data across more than 100,000 files. Summaries of all the data can be found in the species level appendices. In the results section we present notable examples from the species and results which bring together the analysis for all species.

Here we first describe the results of applying individual measures for each of the analysed species (grouped according to the ecosystem service they provide) with the emphasis on the most effective ones. The full summaries including all the analysed measures are presented in the species-level appendices. Next, effectiveness of each of measures is presented across species and countries. Next, steps and results of the multi-criteria decision-making process are shown. Finally, we describe results of 'optimum' stacking scenarios for each of the species analysed.

Table 13 Overview of countries that were run for individual species and different scenarios. All six countries include Germany (DE), Denmark (DK), Poland (PL), Netherlands (NL), Finland (FI) and France (FR).

Species	Baseline	Component scenarios	Stacked scenarios	Diversification
<i>C. septempunctata</i> and <i>A. fabae</i> , <i>A. pisum</i> , <i>M. persicae</i> and <i>S. avenae</i>	all six	DE, DK	all six	DK
<i>E. atra</i>	all six	DE, DK, PL	all six	DE, DK
<i>O. fuscus</i>	all six	DE, DK, PL	all six	DE, DK
<i>B. lampros</i>	all six	DE, DK, PL	all six	DE, DK
<i>A. arvensis</i>	all six	all six	all six	DE, DK

<i>L. europaeus</i>	all six	all six	all six	DE, DK
<i>M. agrestis</i>	all six	all six	all six	DE, DK
<i>O. bicornis</i>	all six	all six	all six	DE, DK

3.1 Baselines

The baselines are the current status-quo before scenarios are applied. They provide insight into current populations and as a standard against which we can compare scenarios. Within individual species, the baseline number of individuals varied both between countries and also between landscapes (Figure 27). Finland stands out as a country where we got a lot of variation for ground beetles (*B. lampros*), hares, and the English grain aphid (*Sitobion avenae*) (Figure 28). In each case this was when the populations of those species were very low (Figure 27). In these low population cases, the population could vary between being entirely extirpated in the landscape or having high numbers. This also potentially an artefact of the distribution no longer being normal and therefore the standard deviation used in the calculation of the coefficient of variation (CV) being incorrect. The aphid species are each strongly tied to their host crop and as such the population of these pests differ a great deal both between landscapes and between countries. This is clear looking both at the population (Figure 27) and CV (Figure 28).



Figure 27 Mean number of each individual species in each landscape and in each country.



Figure 28 Coefficient of variation of individual species in each landscape and in each country showing variation within a species.

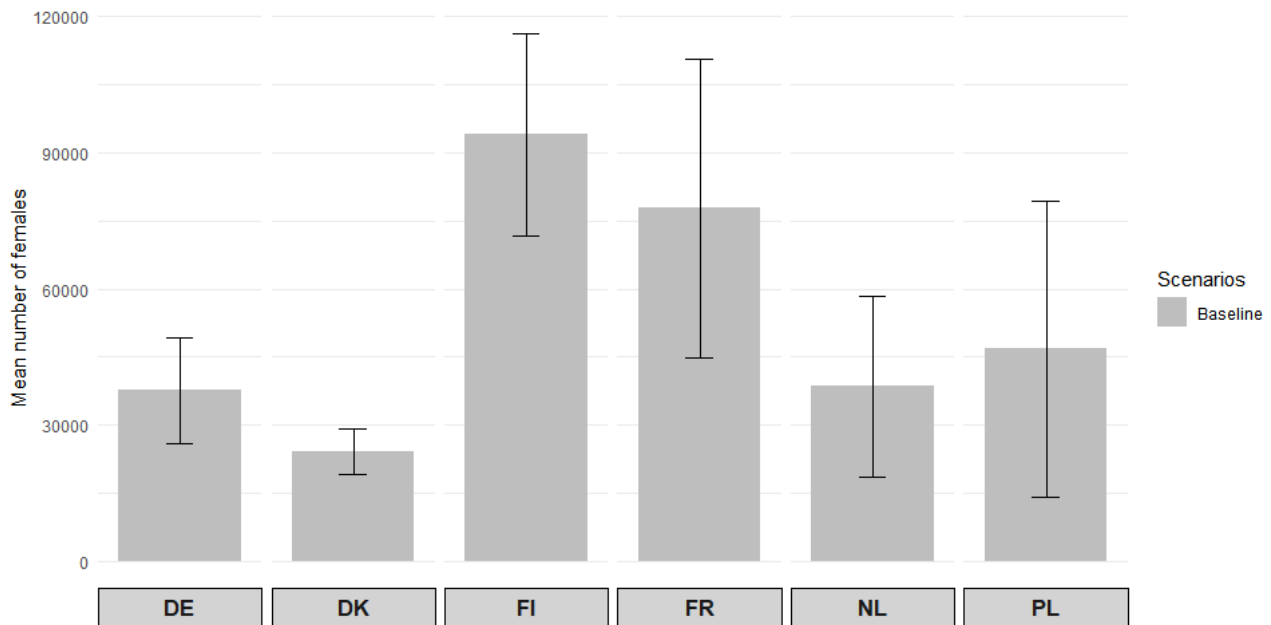
3.2 Species-specific responses to individual measures

3.2.1 Pollinator ecosystem services

3.2.1.1 Red mason bee (*O. bicornis*)

Variability in population numbers *O. bicornis* was clearly visible across countries, while differences between landscapes at the country level were minor. As one of the limiting factors for *Osmia* populations is the availability of nesting habitats, the most abundant populations of this species in the baseline scenario were found in countries / landscapes with a high proportion of woody vegetation, i.e. in Finland and France (Figure 29).

The scenarios that increased the availability of floral resources had the strongest positive effect on *O. bicornis* populations, with flowering field margins providing the largest relative increase (Figure 30). A scenario with an even mix of flowers and grass also had a strong positive effect, although grassy margins alone had either no effect or a small negative effect on populations. Other scenarios had a negligible effect on *O. bicornis* populations, except for set-aside, which had a positive effect on bees in some agricultural systems (Figure 31).



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Figure 29 Comparison of *O. bicornis* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

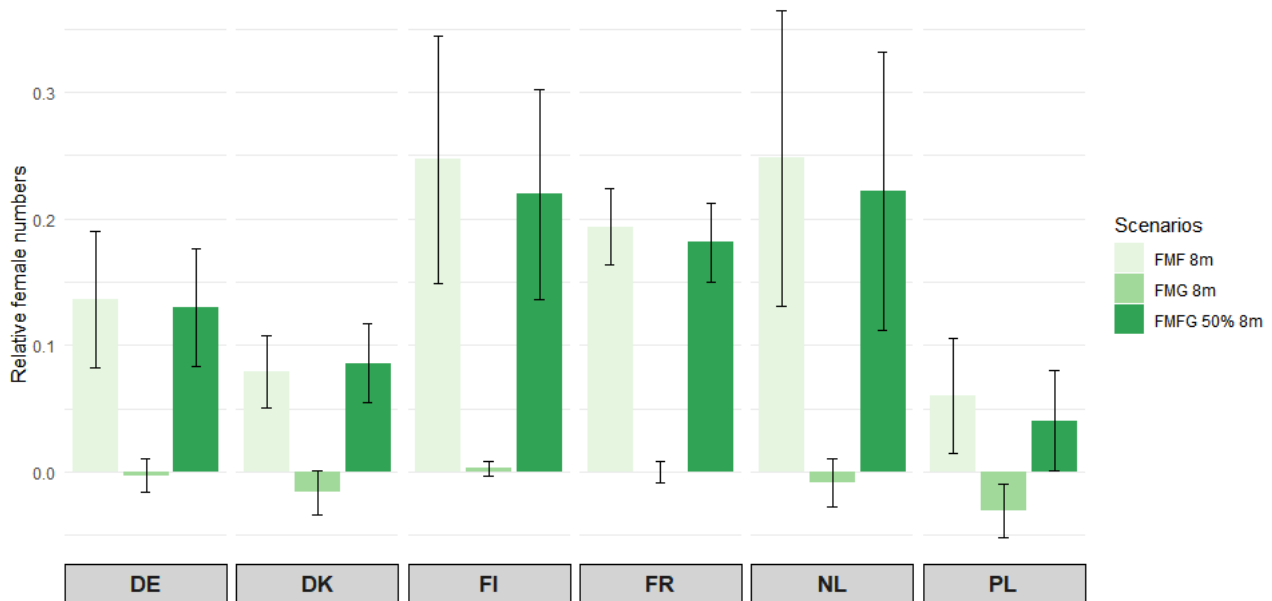


Figure 30 *O. bicornis* flower, grassy and mixed 8m margins bar chart showing the relative number of female *O. bicornis* bees in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

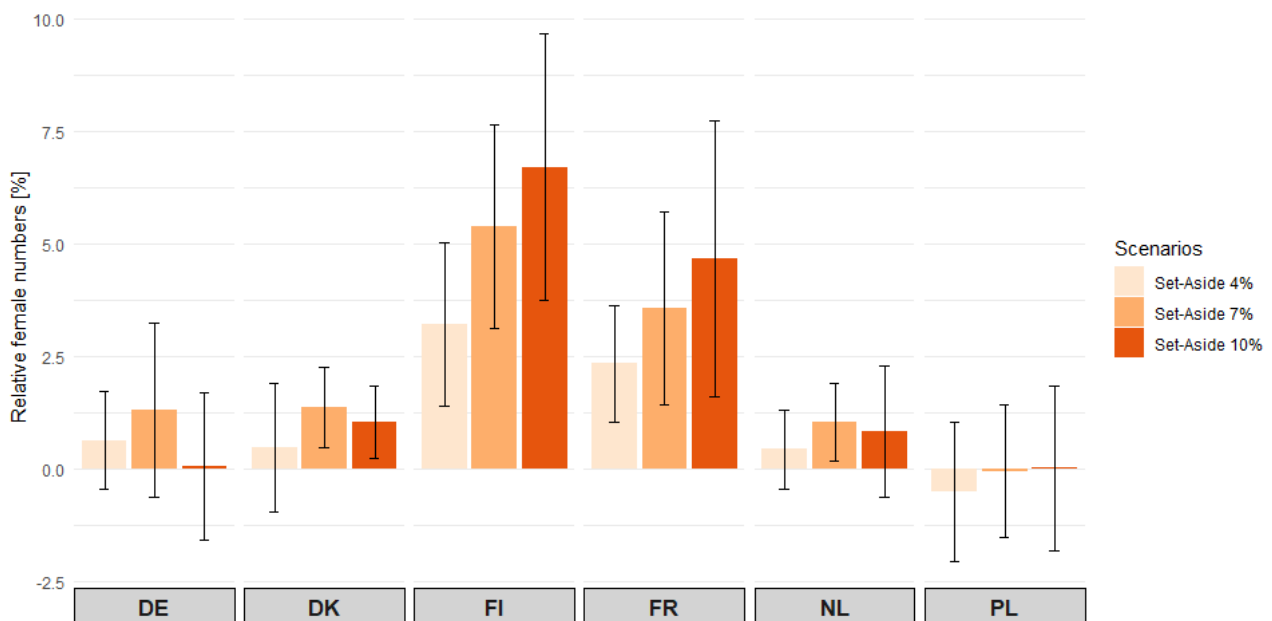
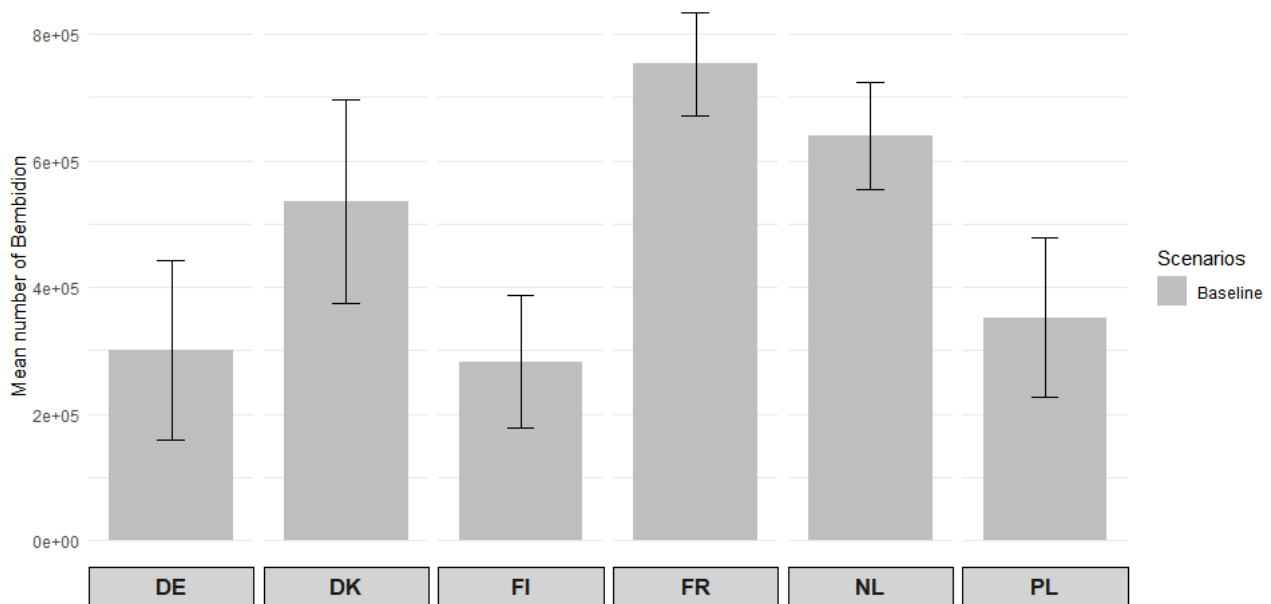


Figure 31 *O. bicornis* set-aside bar chart showing the relative number of female *O. bicornis* bees in each country compared to the baseline including standard deviation (SD).

3.2.2 Predatory invertebrates

3.2.2.1 Ground beetle (*B. lampros*)

The baseline populations of common arable field ground beetle *B. lampros* also varied by country (Figure 32), showing preference for rather more heterogenous landscapes with large coverage of open habitats. The highest population numbers of the beetle were found in France and Netherlands. Initially the species did not survive in Finland when the model was run with the original parameters for winter mortality. Thus, we applied the modified winter mortality model in which the temperature threshold at which winter mortality suddenly increases was lowered to -10°C (these results are shown in the species-level appendices). *B. lampros* populations were most positively affected by field margins, however more by grassy than flower ones (Figure 33). *B. lampros* populations responded positively also to set-aside and biopesticide (Figure 34, Figure 35), but effectiveness of these measures was lower than field margins.



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Figure 32 Comparison of *B. lampros* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

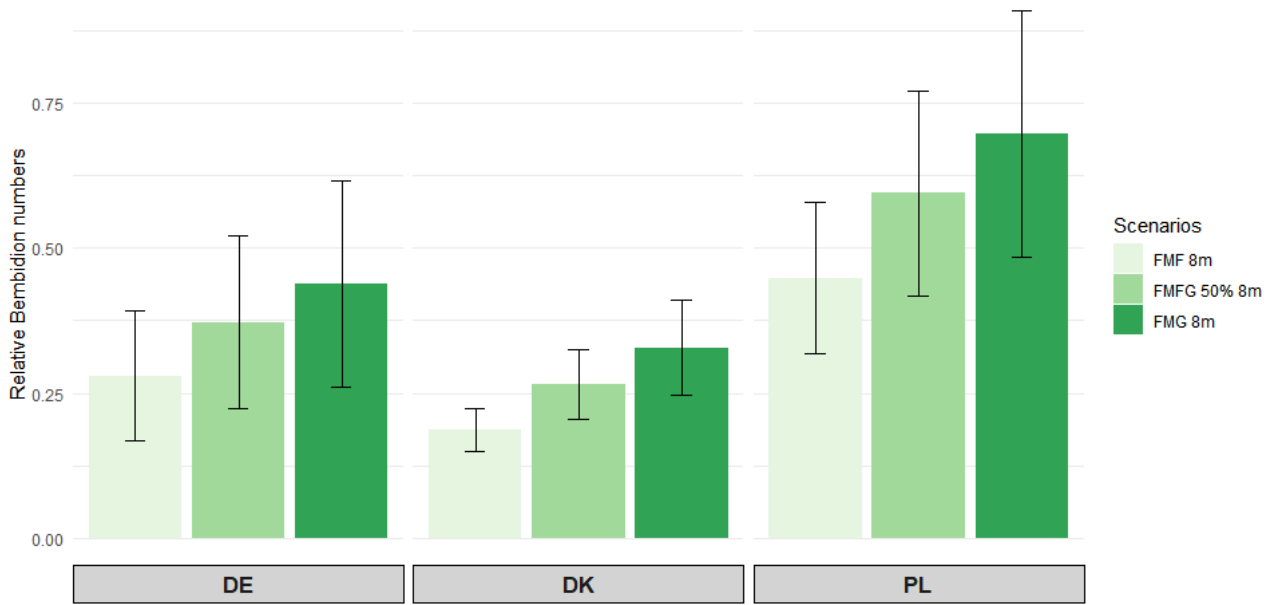


Figure 33 *B. lampros* flower, grassy and mixed 8m margins bar chart showing the relative number of female *B. lampros* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

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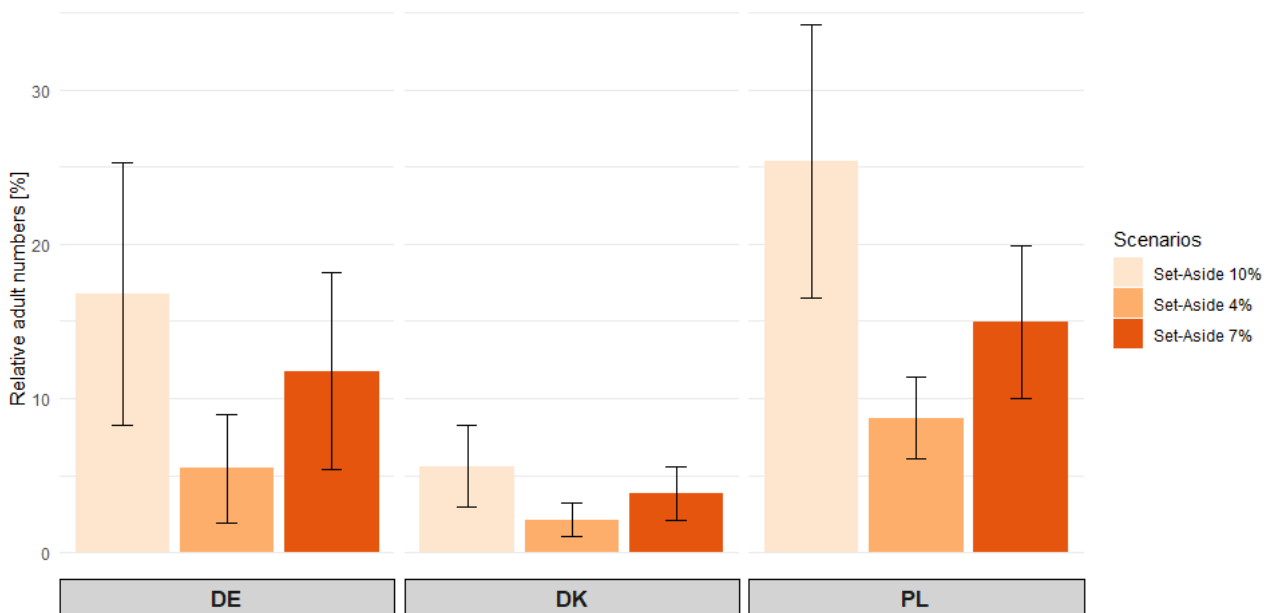


Figure 34 *B. lampros* set-aside bar chart showing the relative number of female *B. lampros* in each country compared to the baseline including standard deviation (SD).

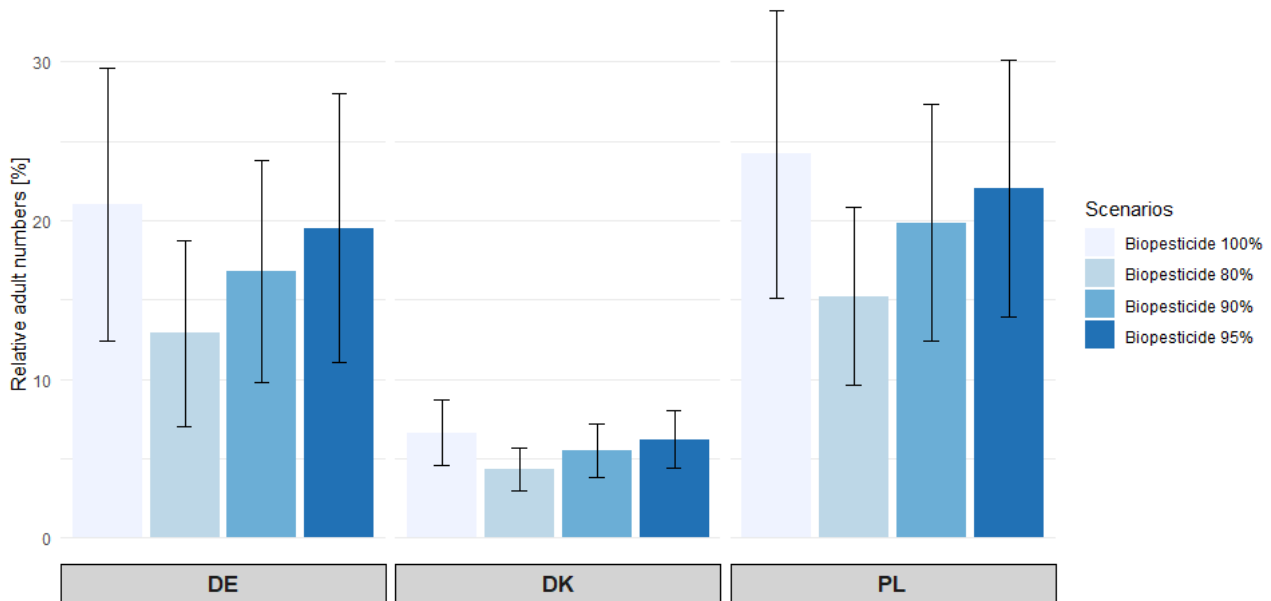


Figure 35 *B. lampros* biopesticide bar chart showing the relative number of *B. lampros* adults in each country compared to the baseline including standard deviation (SD).

3.2.2.2 Spider (*O. fuscus*)

The big differences in the baseline populations of *O. fuscus* were noted across countries, with species numbers in Poland and Finland being 2.5-3 times lower than in France and the Netherlands (Figure 36). *O. fuscus* was most positively affected by field margins with a preference towards flower coverage (Figure 37). Similarly to the ground beetle, other important measures (but not so effective as field margins) for this species were set-aside (Figure 38) and biopesticides (Figure 39).

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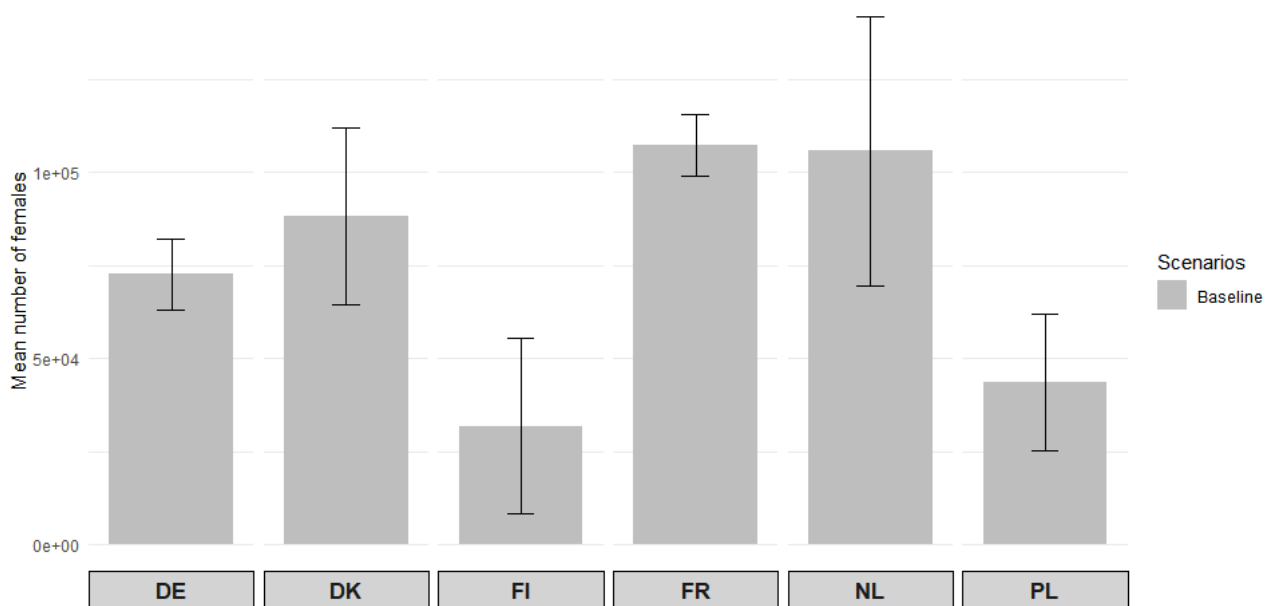


Figure 36 Comparison of *O. fuscus* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

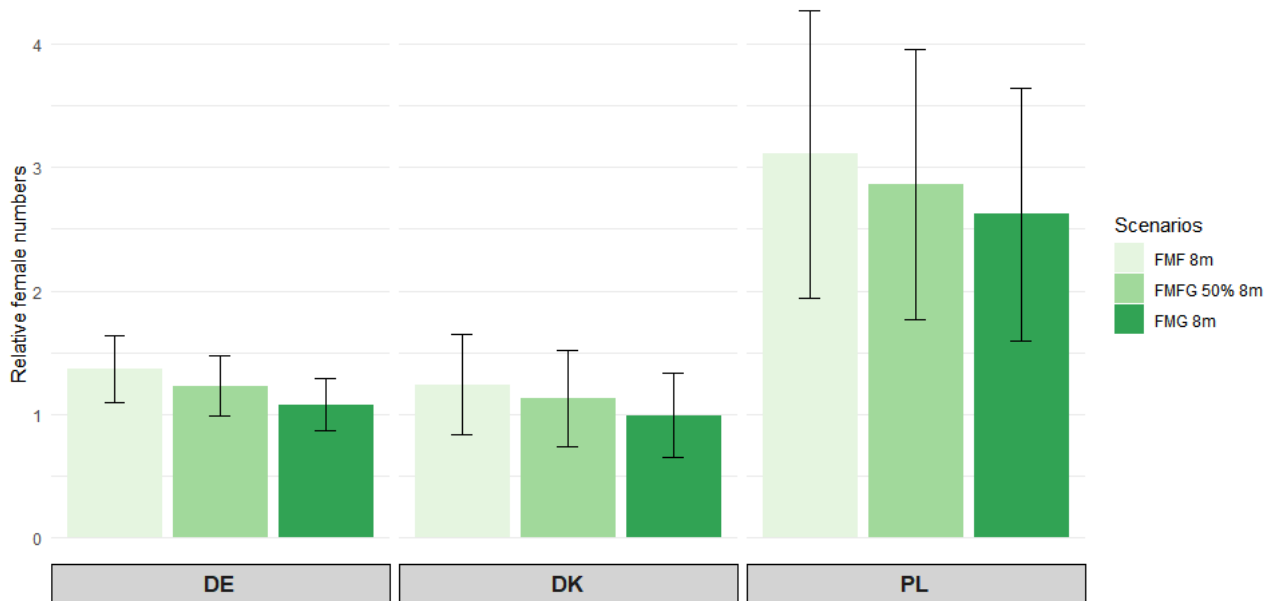


Figure 37 *O. fuscus* flower, grassy and mixed 8m margins bar chart showing the relative number of female *O. fuscus* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

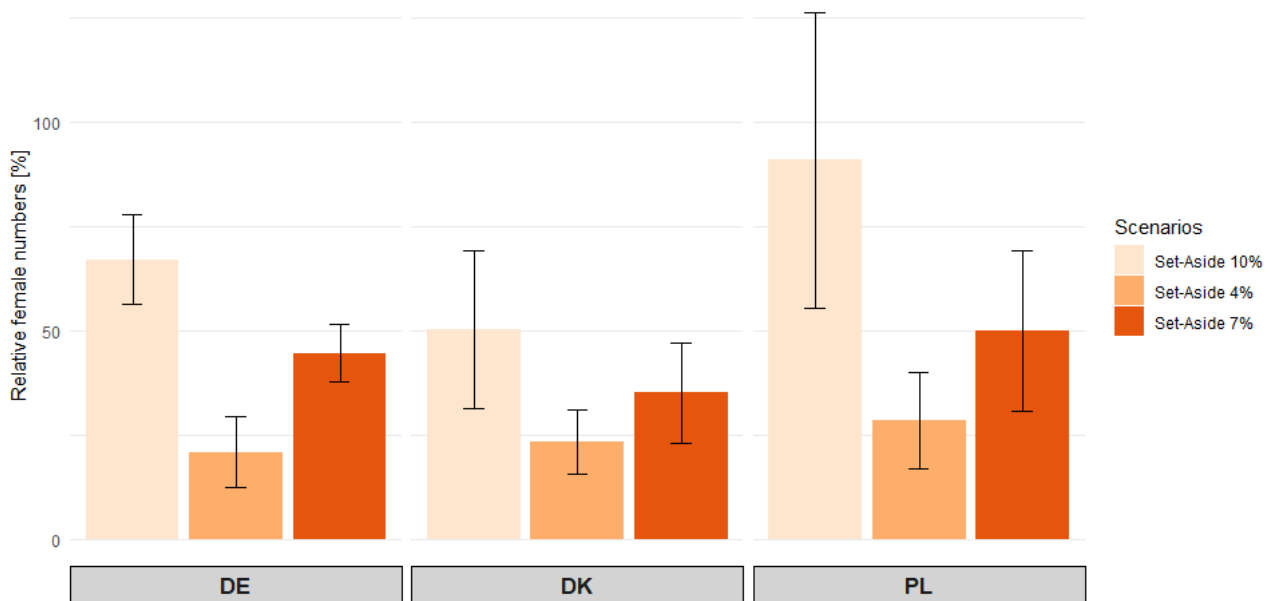


Figure 38 *O. fuscus* set-aside chart bar showing the relative number of female *O. fuscus* in each country compared to the baseline with standard deviation (SD).

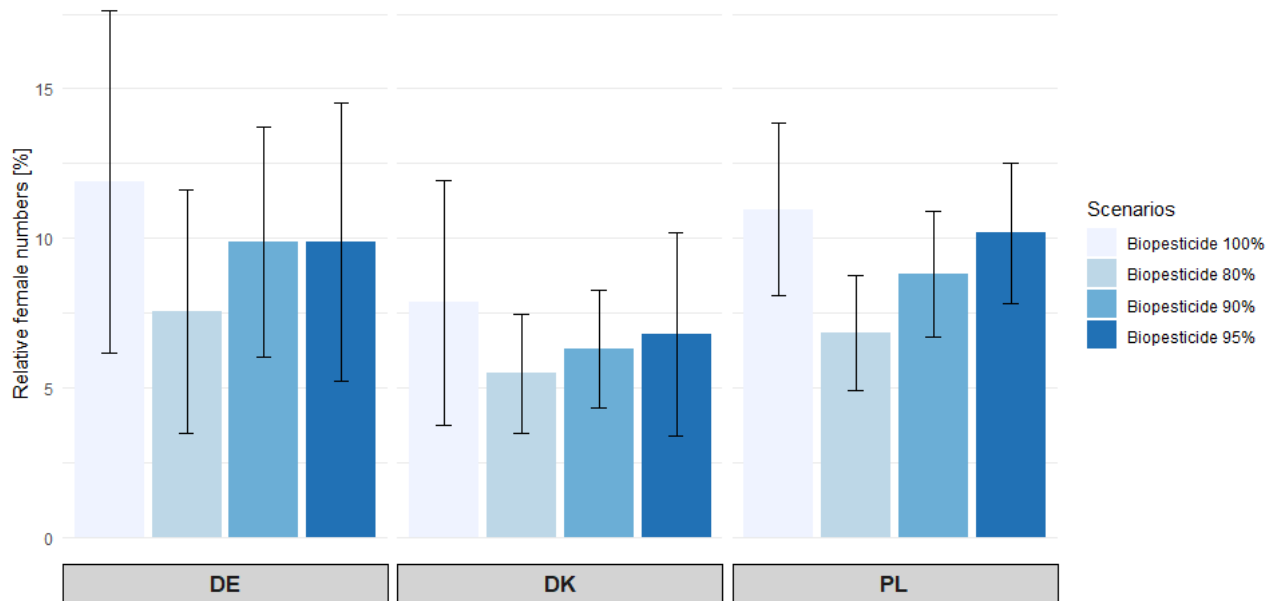


Figure 39 *O. fuscus* biopesticide bar chart showing the relative number of female *O. fuscus* in each country compared to the baseline with standard deviation (SD).

3.2.2.3 Spider (*E. atra*)

Populations numbers of another spider, *E. atra*, were fairly similar across the countries analysed, except in Denmark, where spider numbers were twice or more as high as in other countries (Figure 40). Thus the species response at the country level was very different between *E. atra* and *O. fuscus* (see Figure 36 & Figure 40). This reflects differences in habitat preferences and responses to agricultural management of these two Linyphiid spiders.

Similarly to *O. fuscus*, *E. atra* was most positively affected by field margins with preference to flower ones (Figure 41), set-aside (Figure 42, Figure 43), and biopesticide (Figure 44, Figure 45) measures. All of these measures showed were the most effective in Poland, but that was because the baseline spider populations in this country was the lowest. In fact, looking at Figure 36 showing the absolute rather than the relative changes in spider numbers (as in all other graphs), we can clearly see that adding field margins in Poland, brings the spider populations more in line with the baselines in Germany and Denmark.

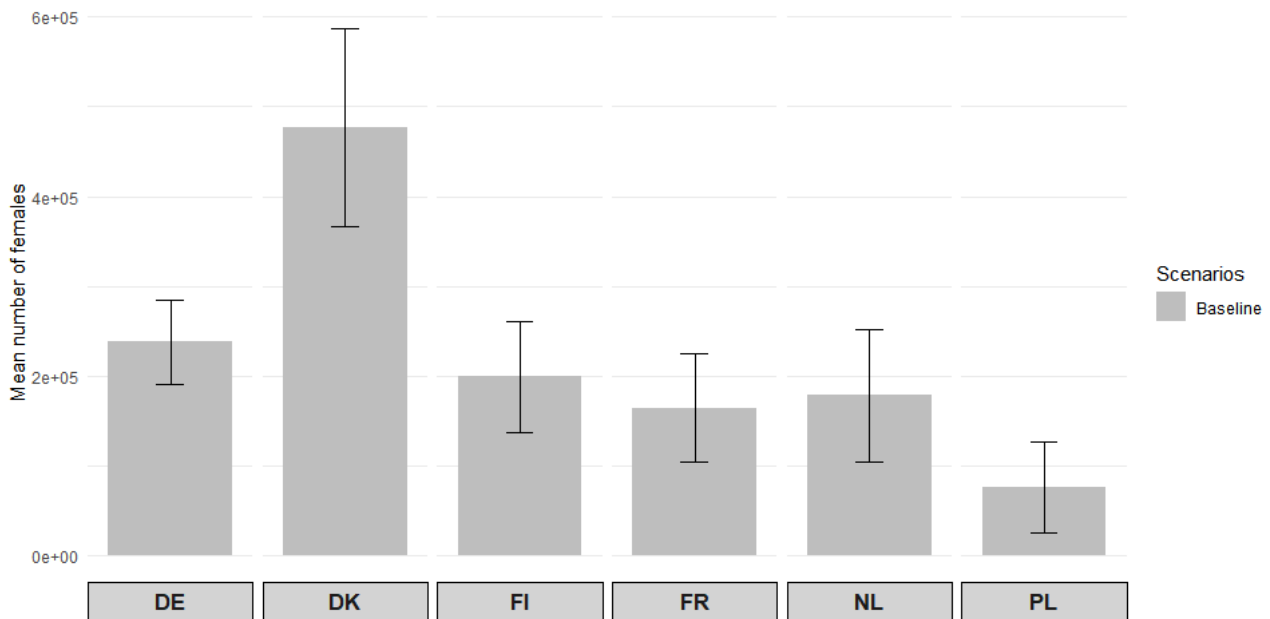


Figure 40 Comparison of *E. atra* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

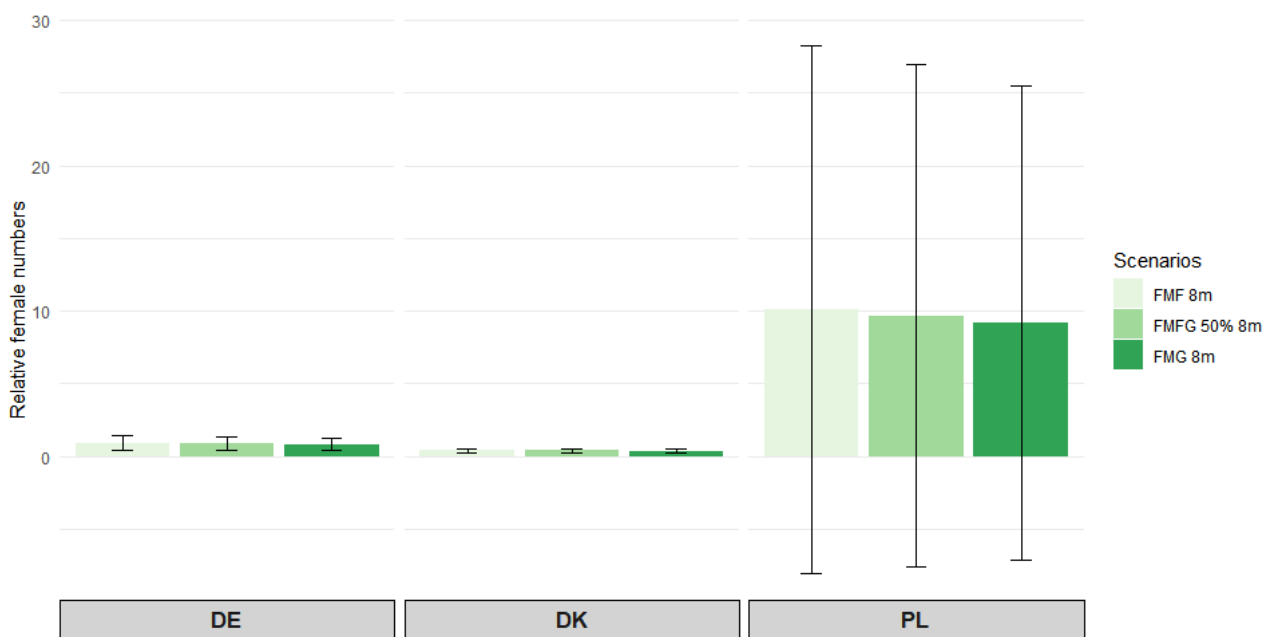


Figure 41 *E. atra* flower, grassy and mixed 8m margins bar chart showing absolute numbers of female *E. atra* in each country. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

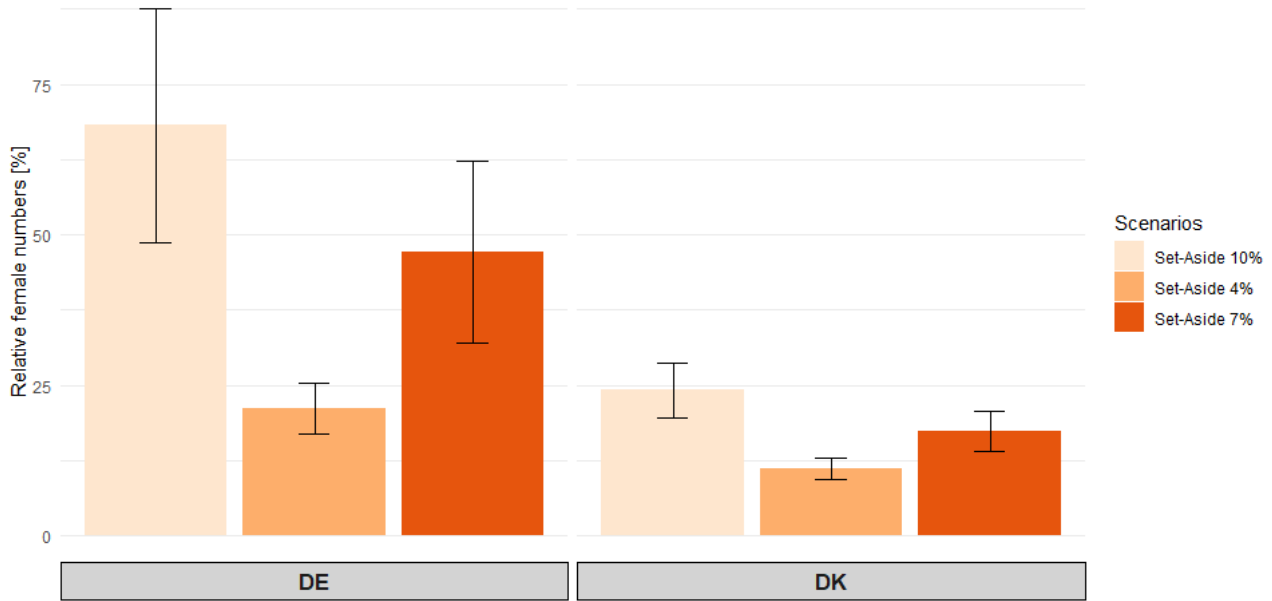


Figure 42 *E. atra* set-aside bar chart showing the relative number of female *E. atra* in each Germany and Denmark compared to the baseline including standard deviation (SD).

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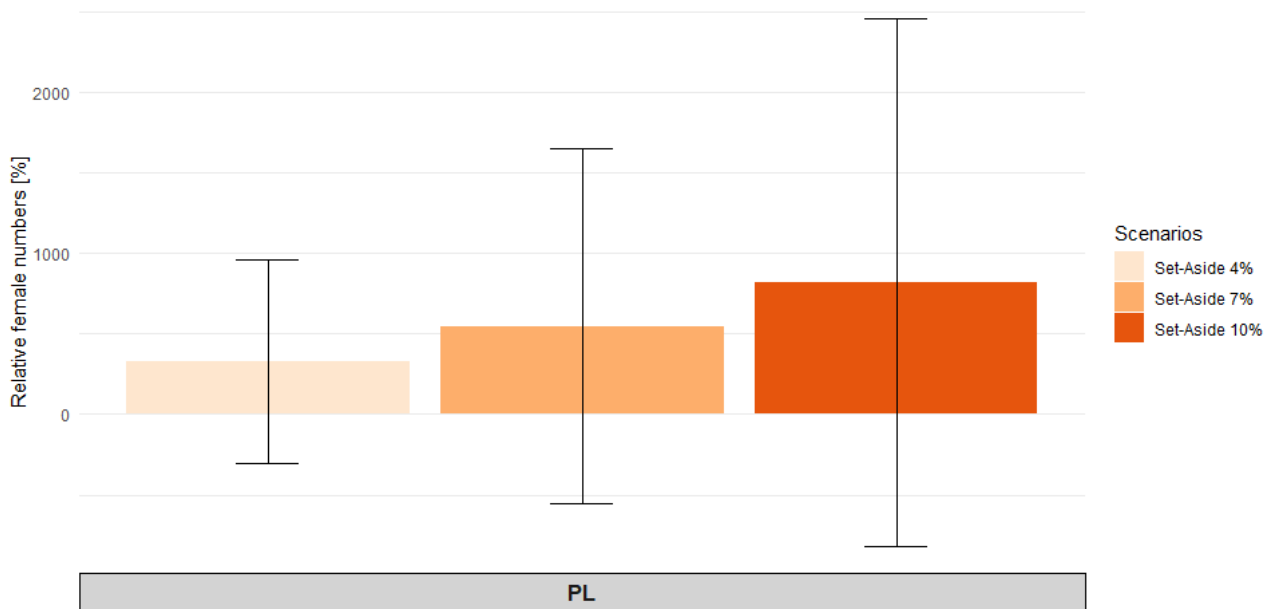


Figure 43 *E. atra* set-aside bar chart showing the relative number of female *E. atra* in Poland compared to the baseline including standard deviation (SD).

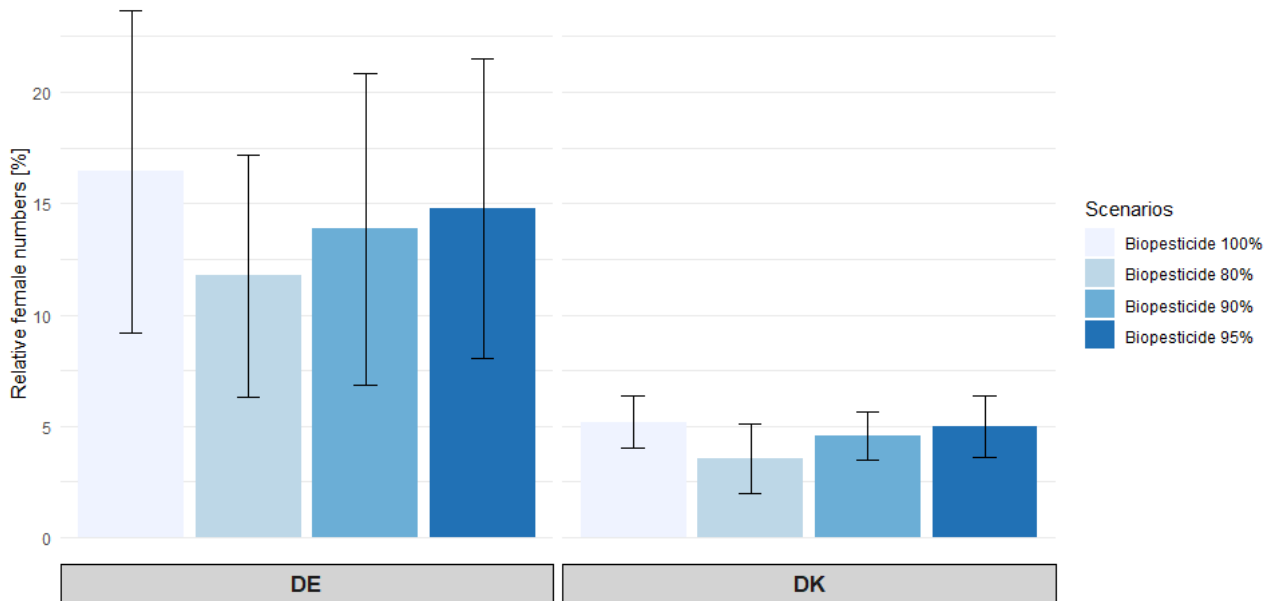


Figure 44 *E. atra* biopesticide bar chart showing the relative number of female *E. atra* in Germany and Denmark compared to the baseline including standard deviation (SD).

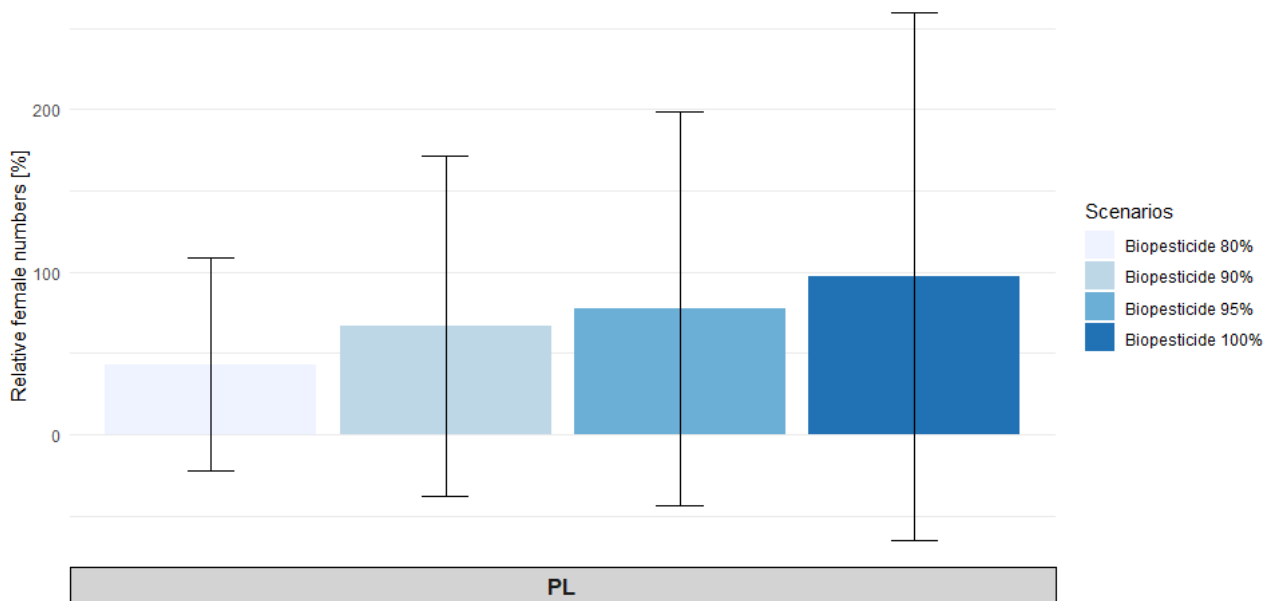


Figure 45 *E. atra* biopesticide bar chart showing the relative number of female *E. atra* in Poland compared to the baseline including standard deviation (SD).

3.2.3 Integrated pest management

3.2.3.1 Aphids (*Aphis fabae*, *Acyrtosiphon pisum*, *Myzus persicae* and *Sitobion avenae*)

Aphid population size and composition within the different landscapes and countries is heavily dependent on the amount and types of crops available. The total number of aphids varied widely among the different countries (Figure 46), with aphid numbers being noticeably lower in Finland in many of the landscapes. The size of the average population shown in Figure 47 is mainly affected by the peak population sizes in the crops in the summer. Large differences between landscapes e.g., NL ID8 compared to NL ID9 do not necessarily indicate larger aphid outbreaks or outbreak risks.

A clear indication of this crop effect is that aphids were most negatively impacted by the wider field margin scenarios. The type of field margin did not make a difference for aphid population sizes in fields and the effect was similar between the Danish and German landscapes (Figure 48). In general, considering all aphids collectively, most of the aphids were found in the field as can be seen in Figure 47. This decrease in aphid numbers is thus due the reduction in crop available to the aphids, thus not actually indicating a reduction in aphid infestation size and risk. The graph for Finland illustrates this further (Figure 47) where aphid numbers were very restricted in landscapes without suitable hosts, and due to the inclement climate, the in-field population is clearly smaller than all other cases.

All scenarios reducing the amount of crop available to the aphids had a similar negative effect on the numbers of aphids between countries, with the highest reduction of aphid numbers occurring in the 8m field margins and 10% set-aside (Figure 48). Legume scenarios stand out as they showed a slight positive effect in the German landscapes, while having a negative effect in the Danish landscapes (Figure 49), but again this will be due to exactly which crops are replaced by the legumes, in DK they were likely less attractive to the pest than the legume, in DE the reverse.

Biopesticides did not have an effect on the aphid population size in the fields (Figure 50) compared to the baseline where chemical pesticides were used. This is not surprising since the scenario used called for two applications of biopesticides which taken together had at least the same impact on the pest as the traditional approach.

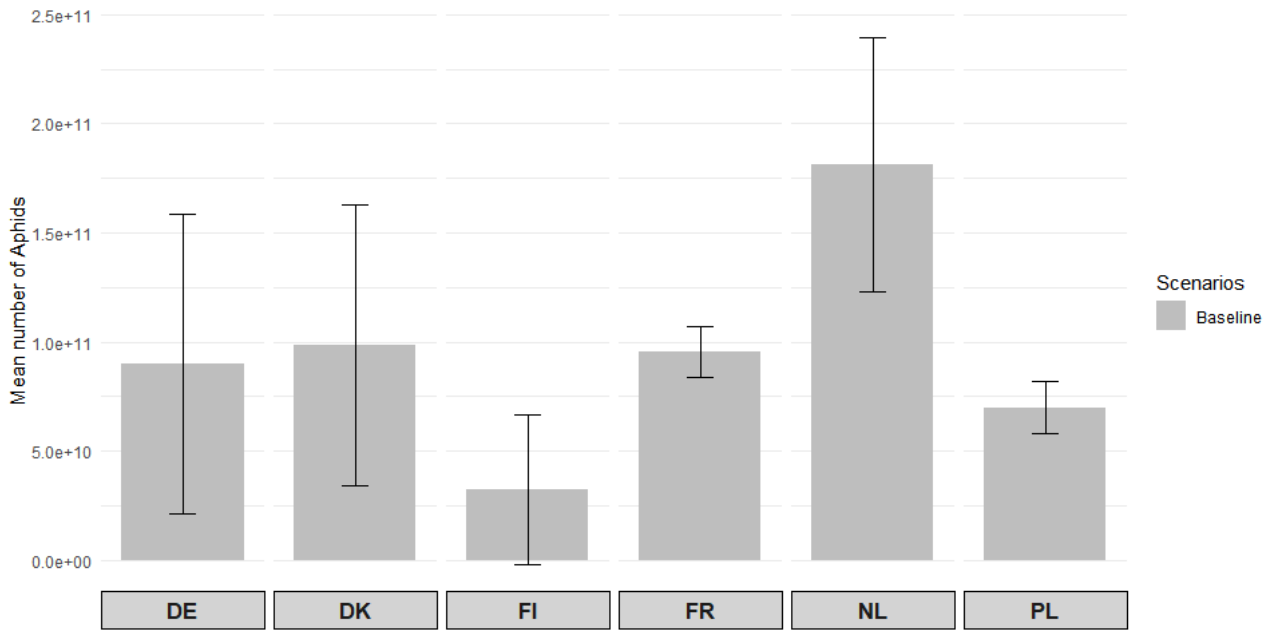


Figure 46 Comparison of all aphids summed baseline runs across countries and landscapes. All aphids summed in the whole landscape Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

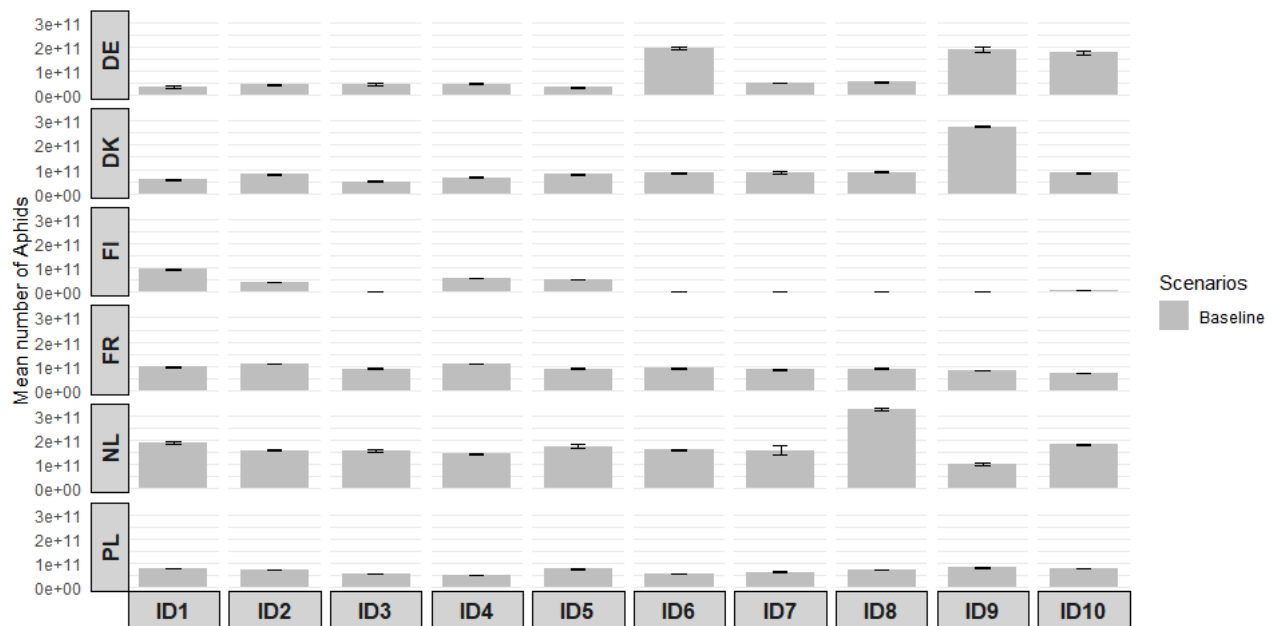


Figure 47 In-field relative to whole landscape comparison of all aphids summed baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

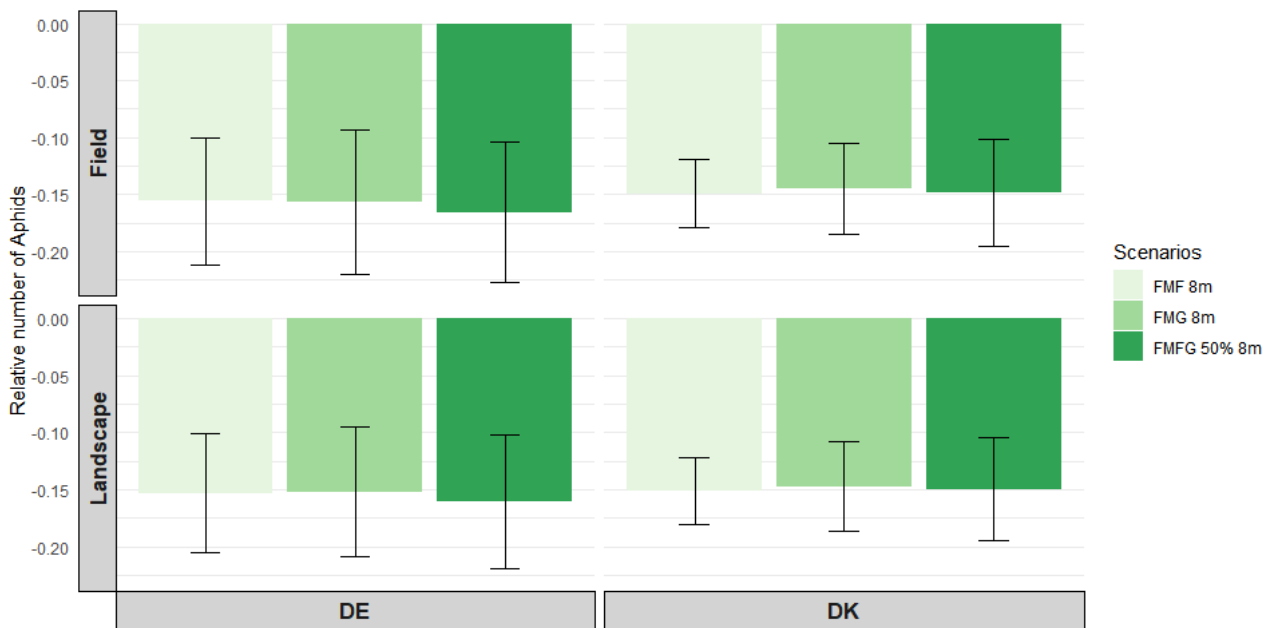


Figure 48 Aphid in the field and landscape under scenarios of grassy margins bar chart showing the relative number of female aphids in each country. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

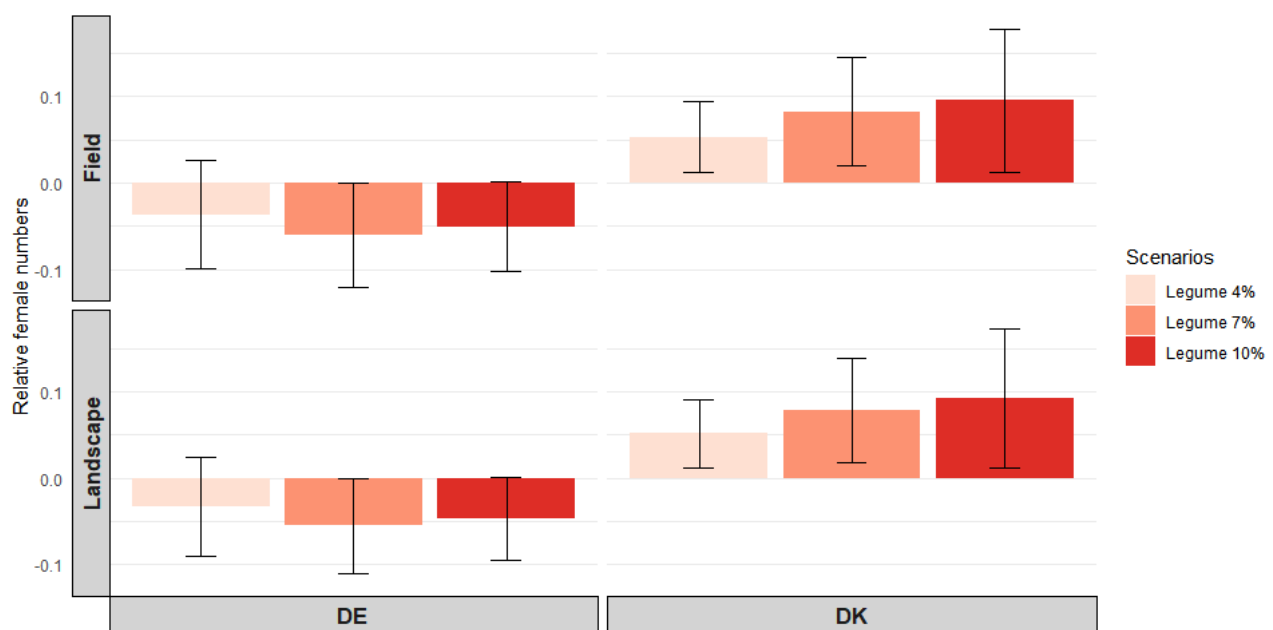


Figure 49 Aphid in the fields and landscape under scenarios of legume. Bar chart the relative number of female aphids in each country. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

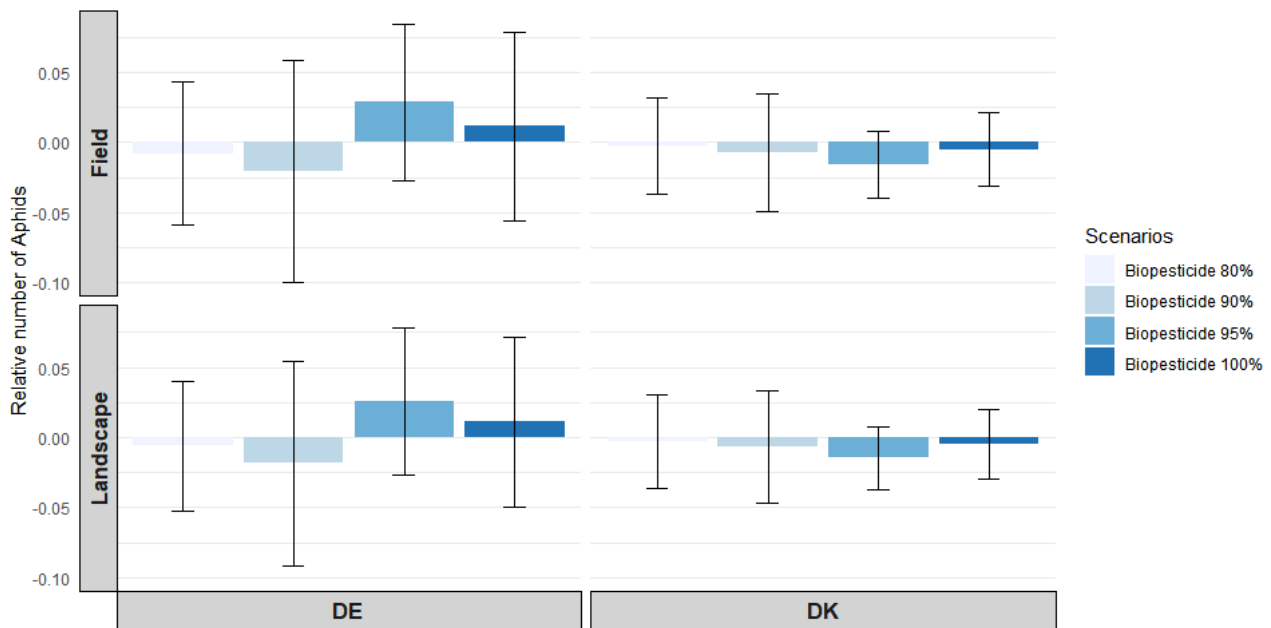


Figure 50 Aphid in the fields and landscape under scenarios of biopesticide. Bar chart showing the relative number of female aphids in each country. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

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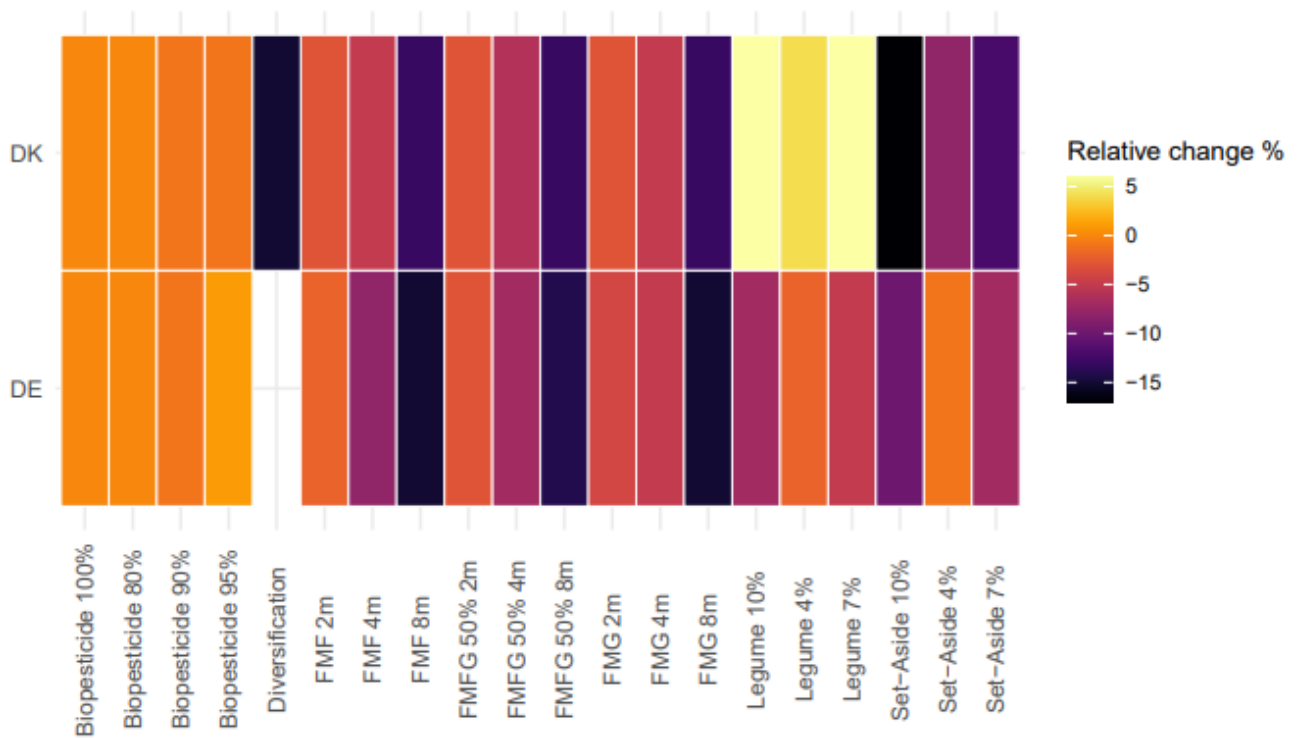
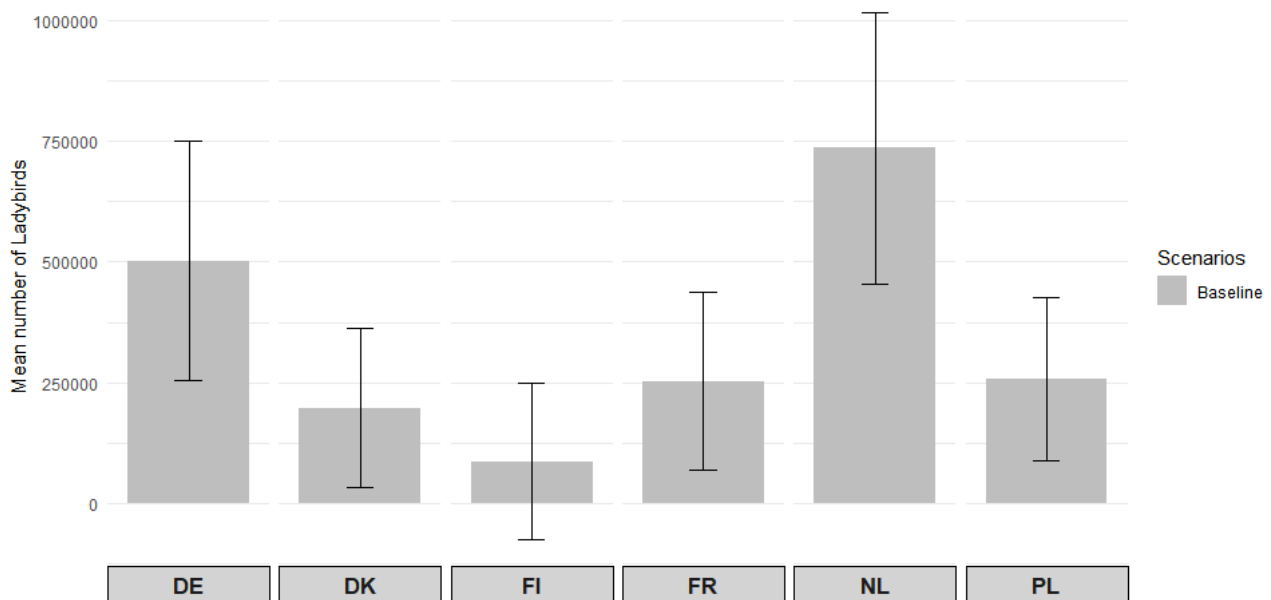


Figure 51 Heatmap showing the relative impact of scenarios in % relative to baseline.

3.2.3.2 Ladybird (*Coccinella septempunctata*)

In the simulations, aphids were the only food source for ladybird larvae, resulting in correlated negative impacts on the ladybird population across all scenarios due to the decline in aphid abundance. The ladybirds were therefore impacted almost proportionally with aphids by the range of scenarios, with the largest reduction in population sizes being the German 8m field margins, 10% set-aside and the mixed 8m field margin with some notable exceptions (Figure 51). The effect of increasing field margins no matter the type (FMG/FMF/FMFG 50%) appears to be different between the Danish and German landscapes (Figure 53), with the Danish landscapes showing no effect or a slight increase in ladybird population, which is the only example where the changes differ from the aphids slightly. Aphid populations in the German landscapes were significantly higher than the populations in the Danish landscapes (Figure 52), potentially being a factor in the different responses to some of the scenarios. The effect of the set aside scenarios is similar across both countries on the ladybird populations (Figure 54). The German landscapes show a similar pattern to the aphids with the increasing field margins sizes decreasing population size.



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Figure 52 Comparison of *C. septempunctata* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

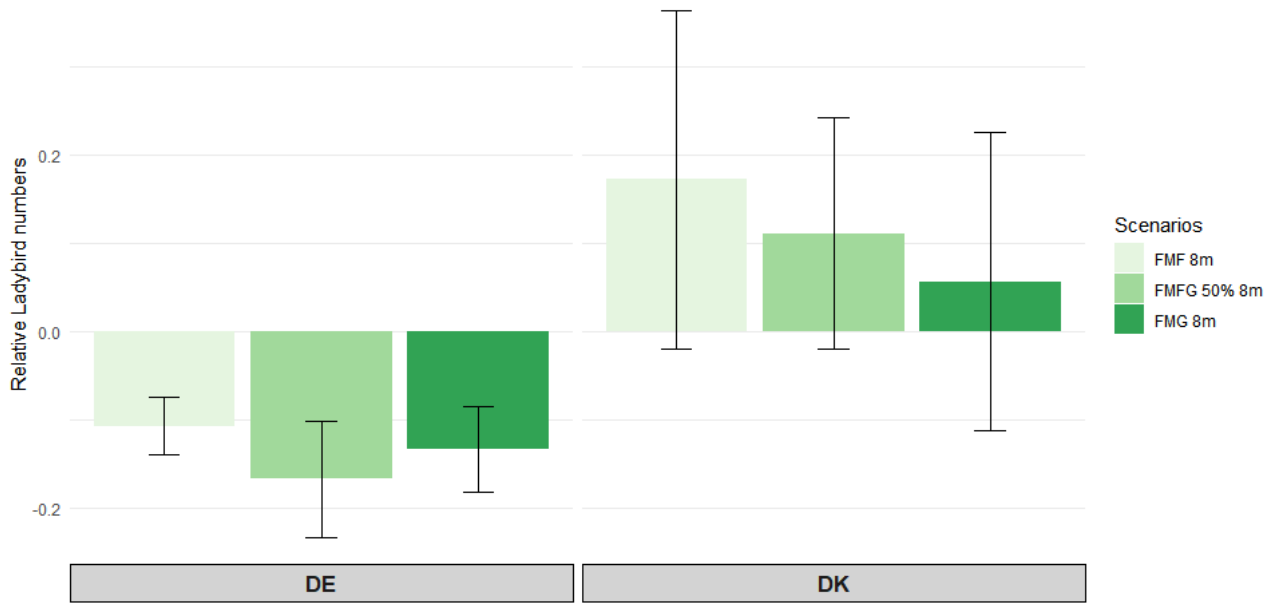


Figure 53 *C. septempunctata*, grassy and mixed 8m margins bar chart showing relative numbers of adult *C. septempunctata* in each country. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

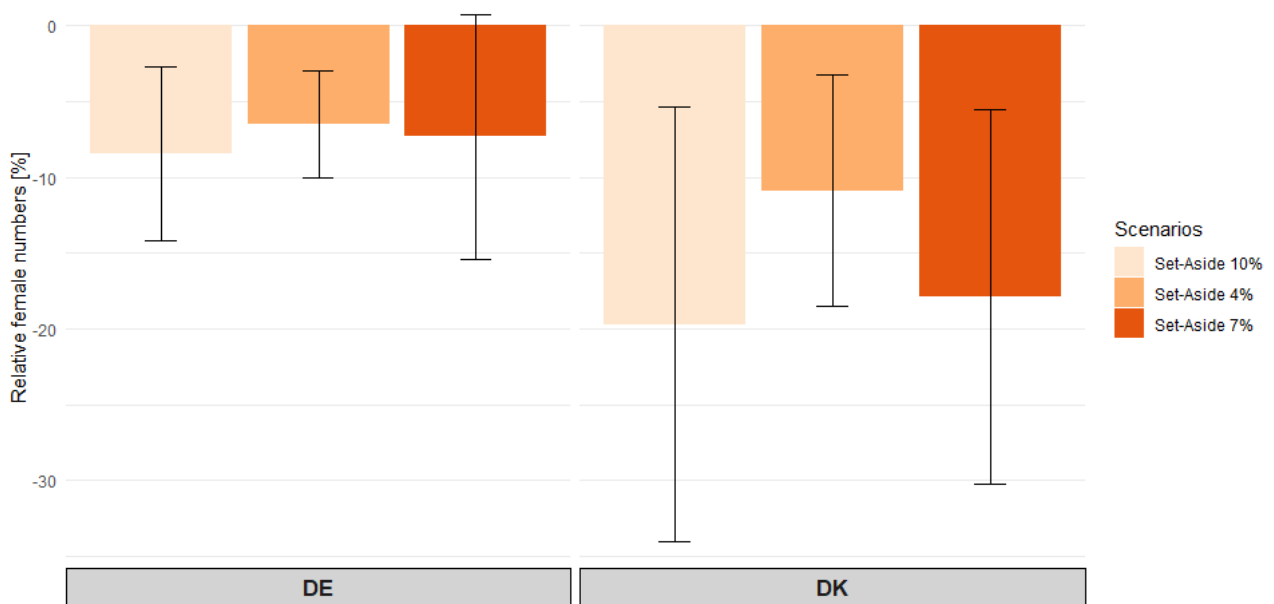


Figure 54 *C. septempunctata* setaside bar chart showing relative numbers of adult *C. septempunctata* in Germany and Denmark compared to the baseline including standard deviation (SD).

3.2.3.3 Ladybird-Aphid Dynamics

Figure 45 shows a visual example of the aphid and ladybird dynamics in time and space. Each picture shows a snapshot in time with aphid densities across a landscape and locations of individual ladybirds. As can be seen ladybirds start in off-crop areas and follow the aphids into the fields, but not with perfect knowledge or coverage. The aphids move into fields and reproduce, but this effect depends on dispersal which can be short-distanced resulting in diffusion into fields, but when population effects and weather create high numbers of alates dispersal is much faster. Consequently, not all suitable hosts are colonised immediately or equally early in the season.

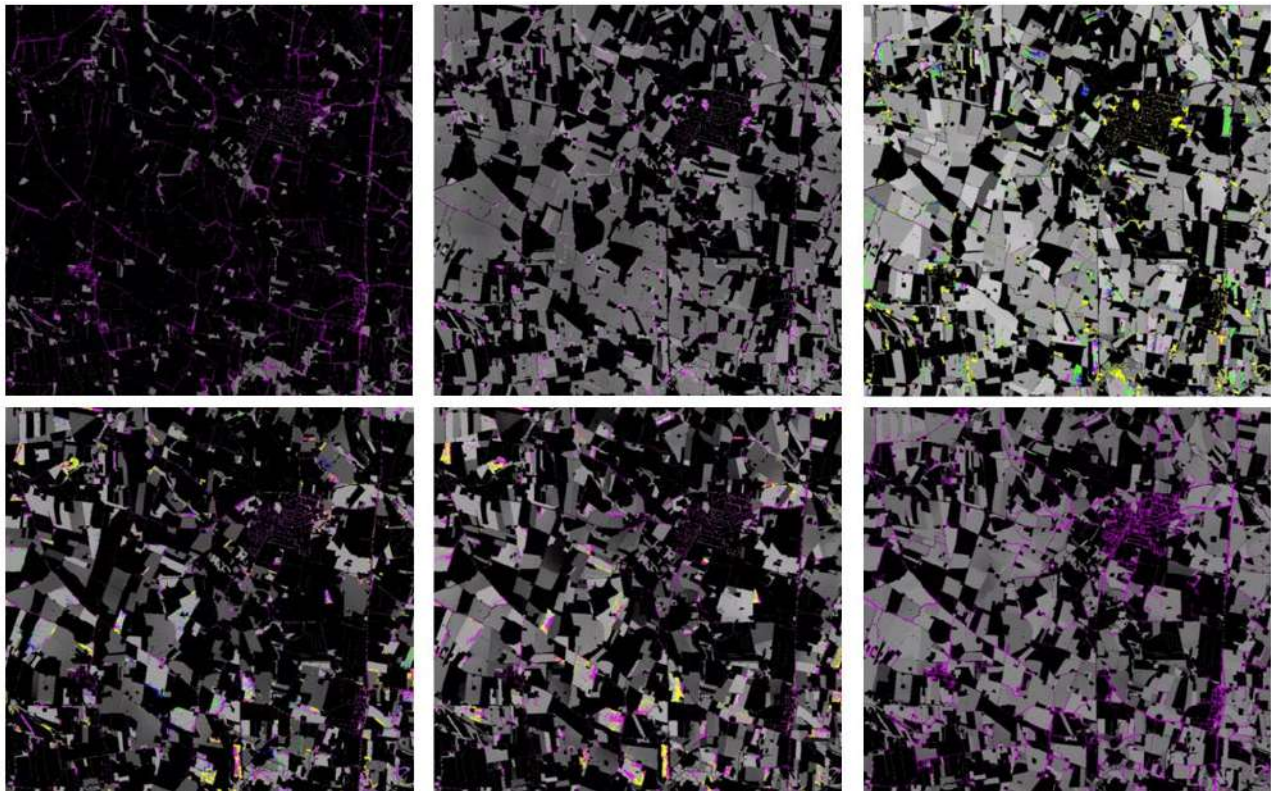


Figure 55 Heatmap time series showing the aphid and ladybird model running together in a Danish 3x3km landscape. Shading represents the density of aphids ranging from black - no aphids to light grey - high aphid densities on a log scale. Coloured dots represent *C. septempunctata* at different life-stages, adults are pink.

Although Figure 55 shows spatial dynamic between ladybirds and aphids within one year, it is important to underline that this dynamic was characterised by large variation from year to year, as a function of both weather and crop choices. In addition, crop choices were impacted by dynamic changes in spatial pattern of crops since the dispersal of aphids is quicker if good host crops are near population sources. Figure 55 also shows that there is little correlation between aphids and ladybird population sizes when looking at certain snapshot in time. This is to be expected, however, since any effect is delayed in time and space, and spatially distributed, hence patterns are masked by the larger scale.

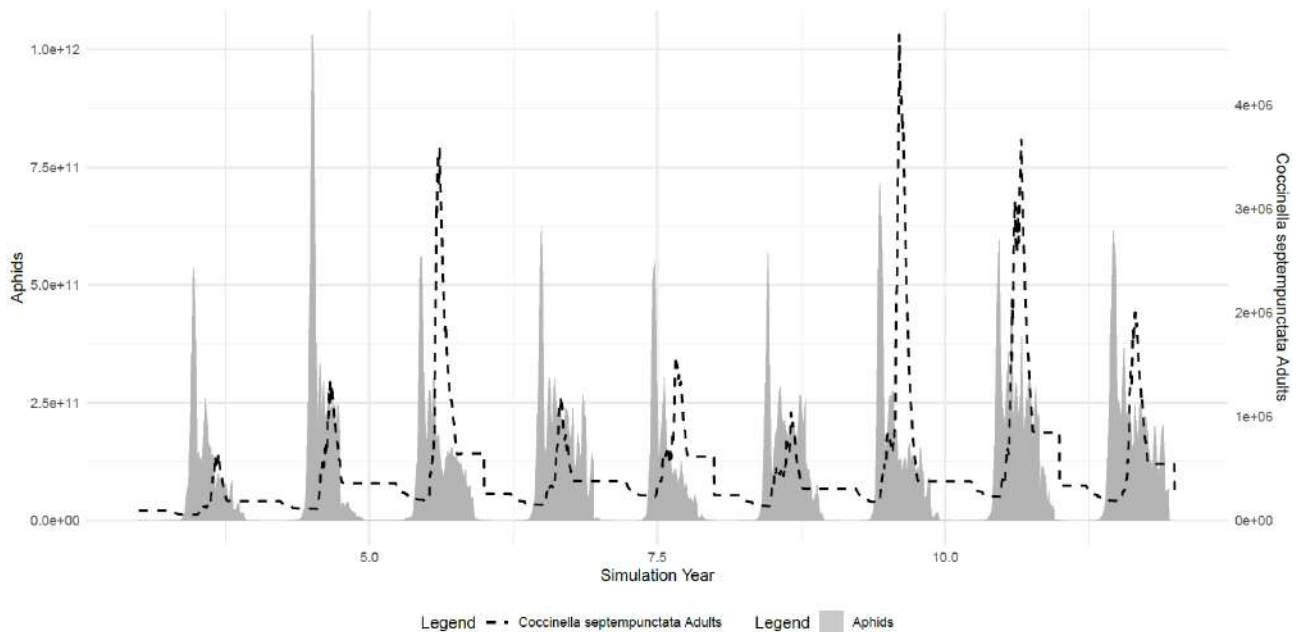


Figure 56 Aphid ladybird population dynamics in NL ID9 across 9 simulation years. The aphid line shows all four aphid species summed in the landscape. The ladybird graph shows adults in the entire landscape.

These patterns can be seen in Figure 56 showing an example time series of aphid and ladybird population across 9 years in a Dutch landscape (NL ID9). Here it is clear that total aphid numbers vary annually with the weather and crops planted, although the second factor ought to be relatively constant between years at the 10x10 km scale. Adult ladybird numbers lag behind the aphid prey as would be expected but are not strongly corrected with total aphid density. This is due to various factors but includes the time-lag because ladybirds are univoltine, the spatial dynamics, where aphids may escape the ladybird, interaction with management, e.g. ploughing can kill an entire field ladybird population if it occurs before they can emerge as adults, and differences in temperature between years which differentially affects aphids and ladybirds.

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3.2.4 Vertebrate species

The European hare and field vole do not respond to biopesticides; however, Eurasian skylark respond through the effect on insect biomass.

3.2.4.1 European hare (*L. europaeus*)

Baseline populations of hare (*L. europaeus*) were much lower in Finland compared to the other countries (Figure 57) as in Finland the species is approaching its northern limit. Hare populations were most positively affected by field margins, especially those covered with grasses (Figure 58). Unlike all other species, hares responded positively to the increase in legumes in crop rotations (Figure 59). The magnitude of this effect varied among countries, which may be associated with the changes in availability of habitats preferred by hares (due to their replacement with legumes) varying across countries. Contrary to invertebrates, hares were not affected by biopesticides.

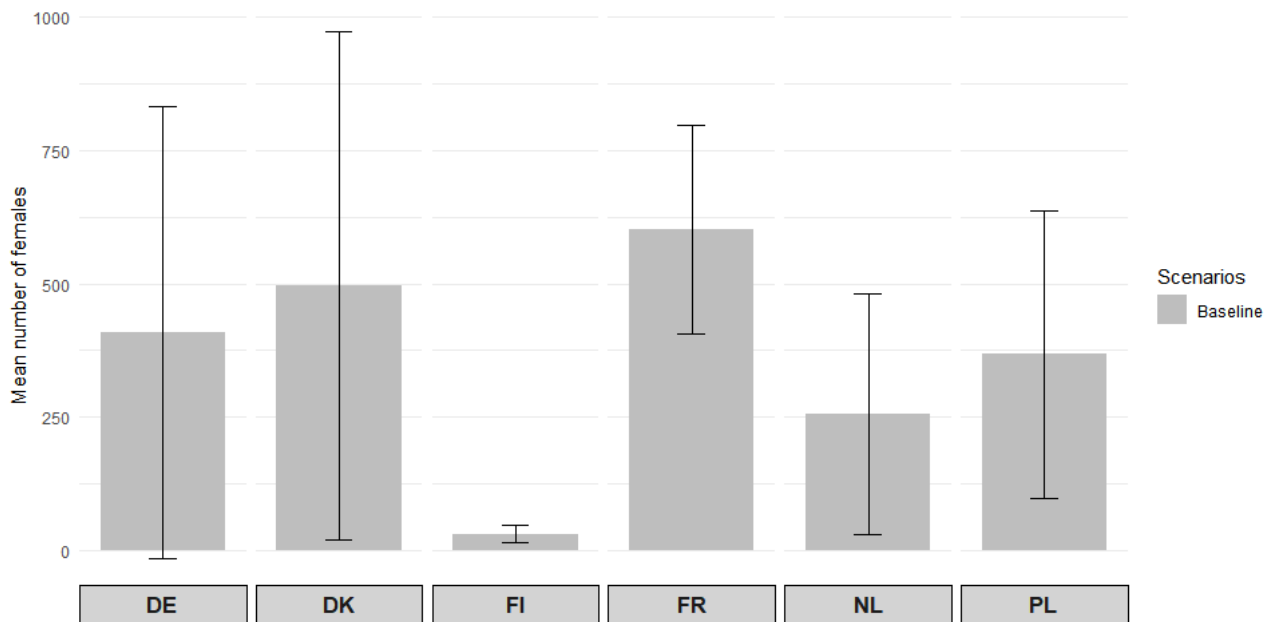


Figure 57 Comparison of Hare baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

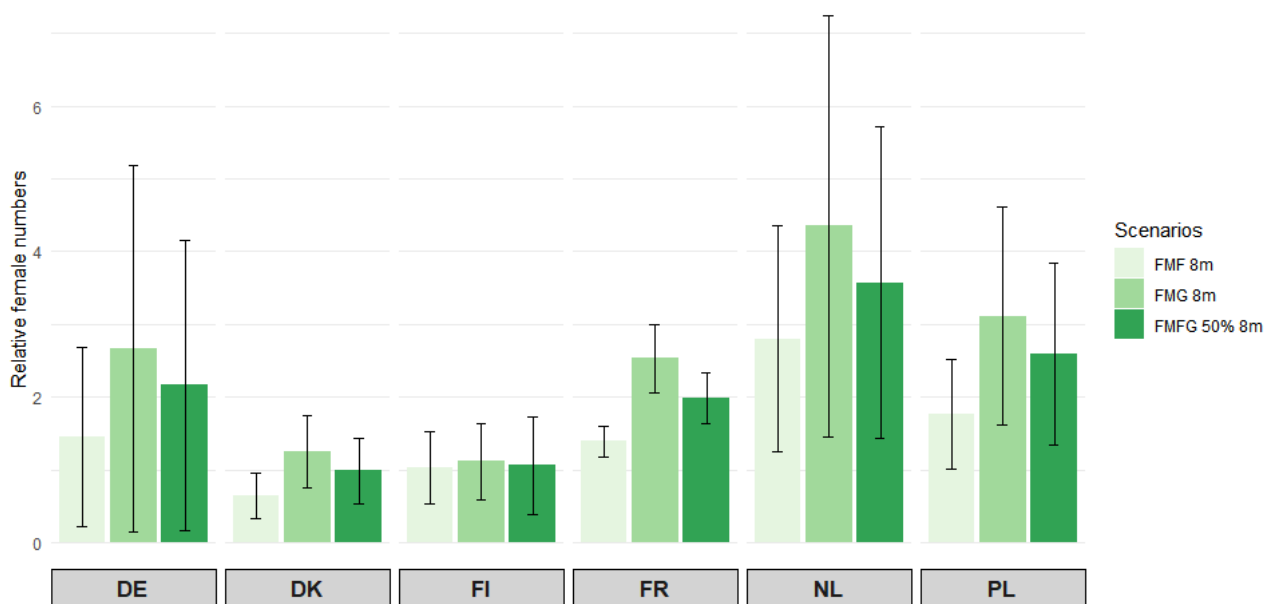


Figure 58 *L. europaeus* flower, grassy and mixed 8m margins bar chart showing the relative number of female *L. europaeus* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

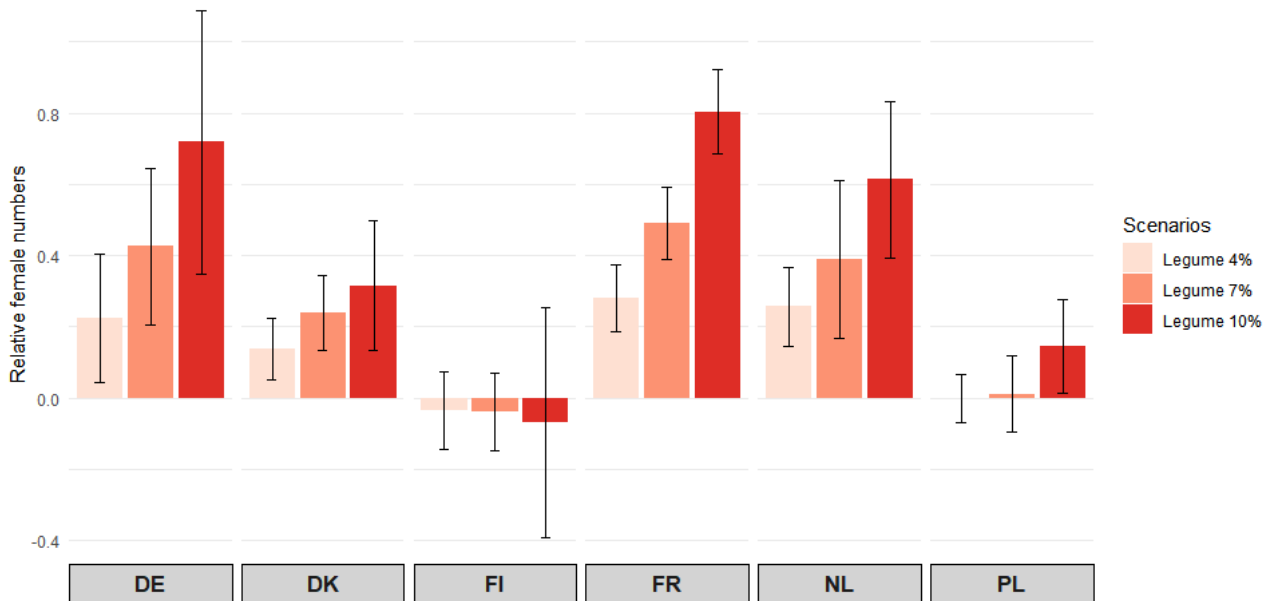


Figure 59 *L. europaeus* legume bar chart showing the relative number of female *L. europaeus* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

3.2.4.2 Eurasian skylark (*A. arvensis*)

Eurasian skylark (*A. arvensis*) baseline populations were highest in Denmark and the Netherlands, and lowest in Germany and France (Figure 60). Like many of the other species, skylarks benefited from introduction of field margins, more flowering than grassy ones (Figure 61). However, in some countries (especially in Denmark), the biggest positive impact on skylark populations was achieved with set-aside scenarios (Figure 62). The legume scenarios resulted in mixed effects depending on the country (Figure 63). For example, in Germany, increasing legumes in crop rotations had a positive effect, while in Poland a clearly negative effect.

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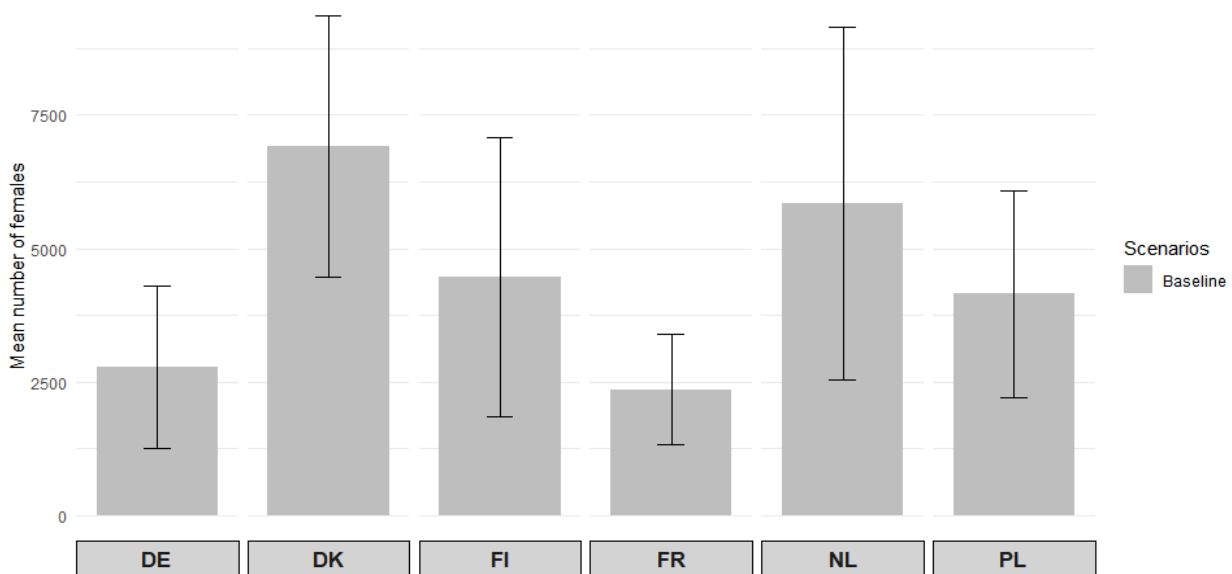


Figure 60 Comparison of *A. arvensis* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

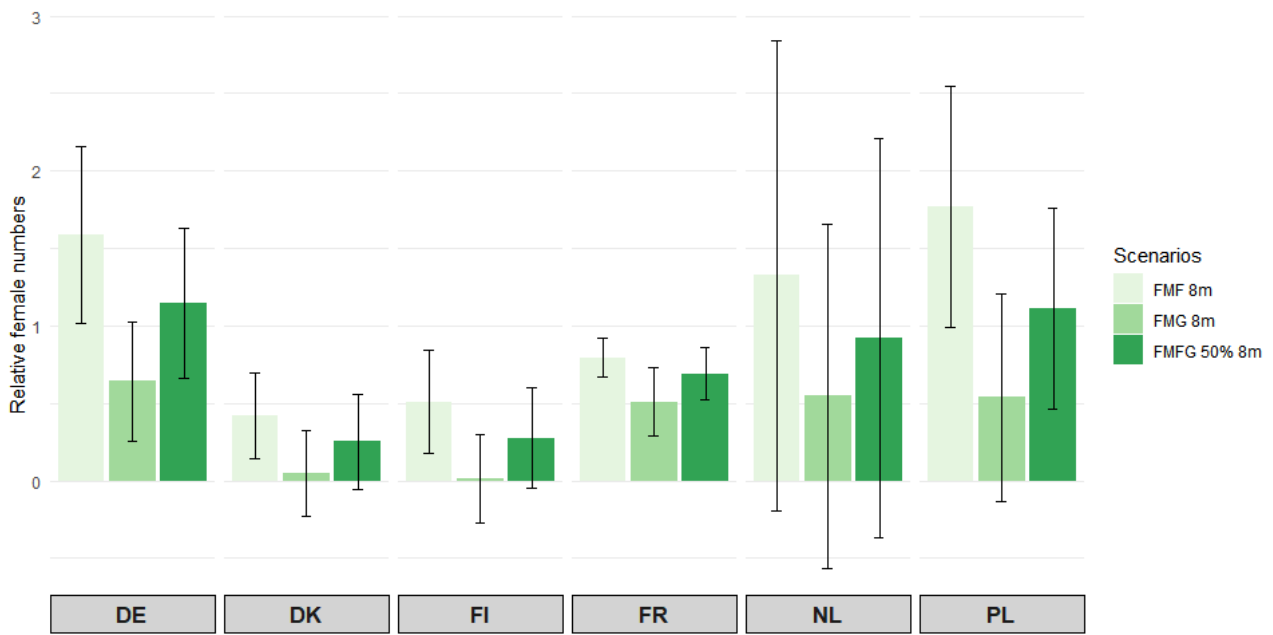


Figure 61 *A. arvensis* flower, grassy and mixed 8m margins bar chart showing the relative number of female *A. arvensis* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

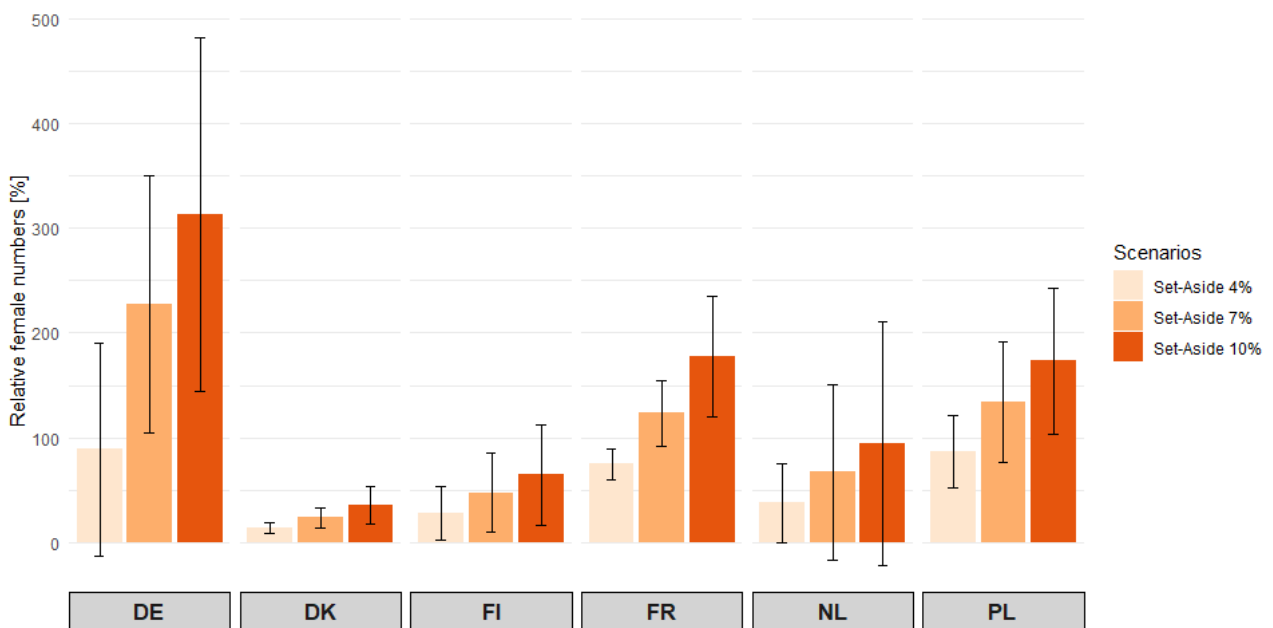


Figure 62 *A. arvensis* set-aside bar chart showing the relative number of female *A. arvensis* in each country compared to the baseline including standard deviation (SD).

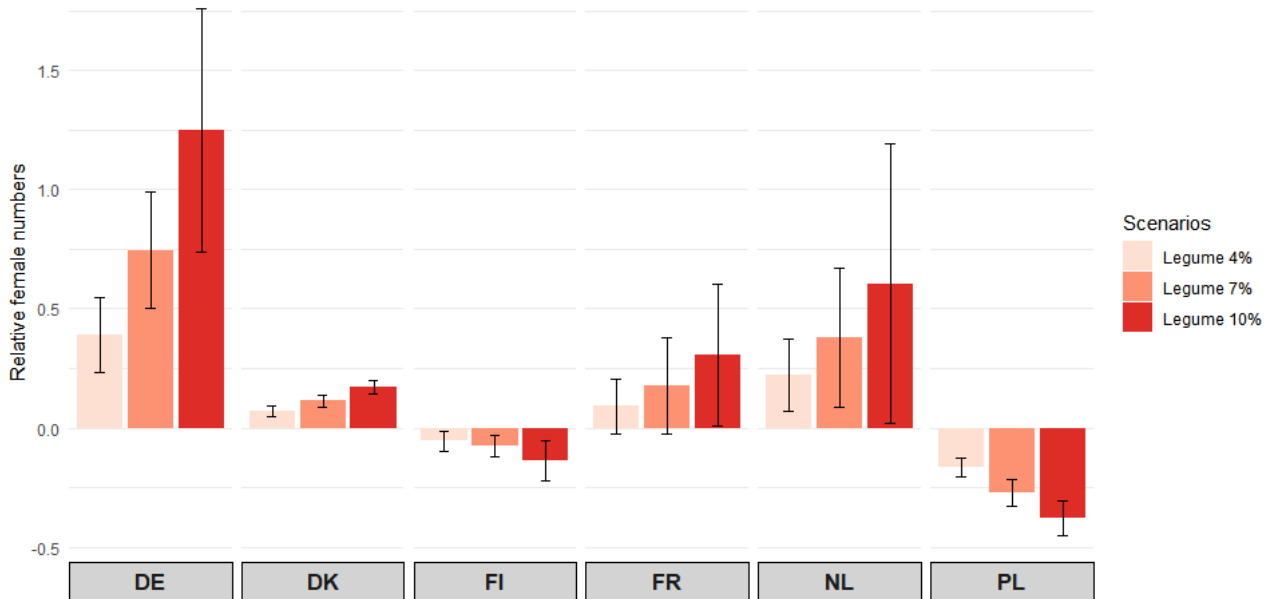


Figure 63 *A. arvensis* legume bar chart showing the relative number of female *A. arvensis* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

3.2.4.3 Field vole (*M. agrestis*)

The baseline populations of field vole (*M. agrestis*) differed strongly between countries analysed and were highest in France and Poland (Figure 64). Contrary to hares, voles were weakly negatively affected by grassy field margins, but strongly positively by flowering field margins or mixtures of grassy and flowering ones (Figure 65). The second important measure for voles, although not so effective as flowering field margins, was set-aside (Figure 66). Similarly to hares, biopesticides did not affected vole populations.

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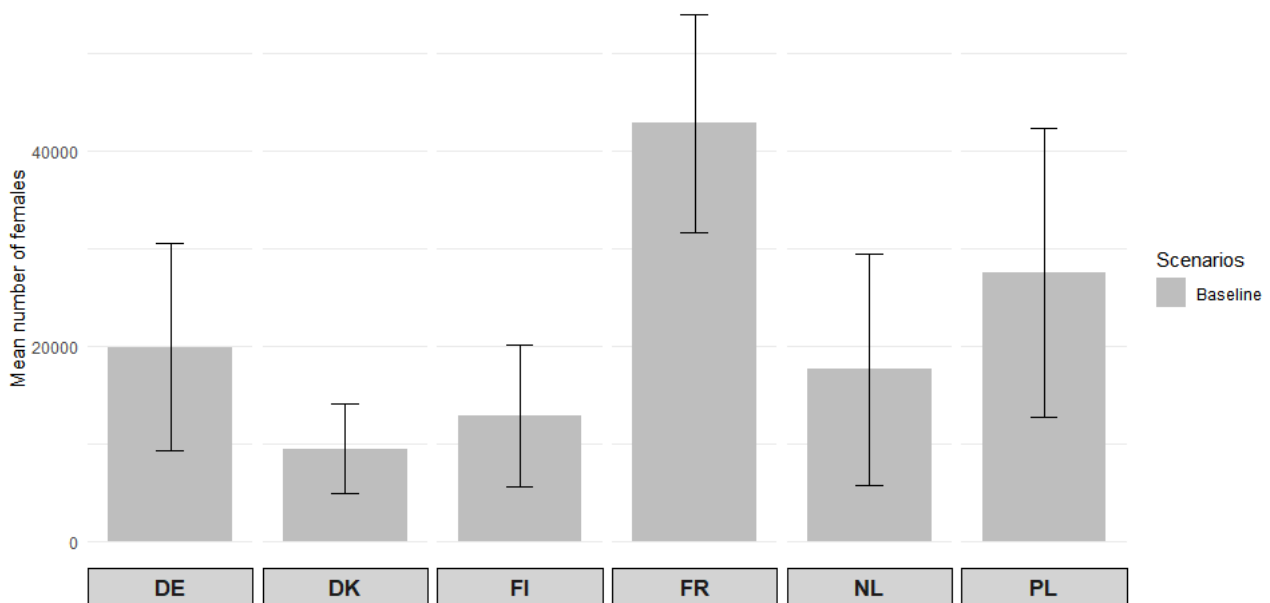


Figure 64 Comparison of *M. agrestis* baseline runs across countries and landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

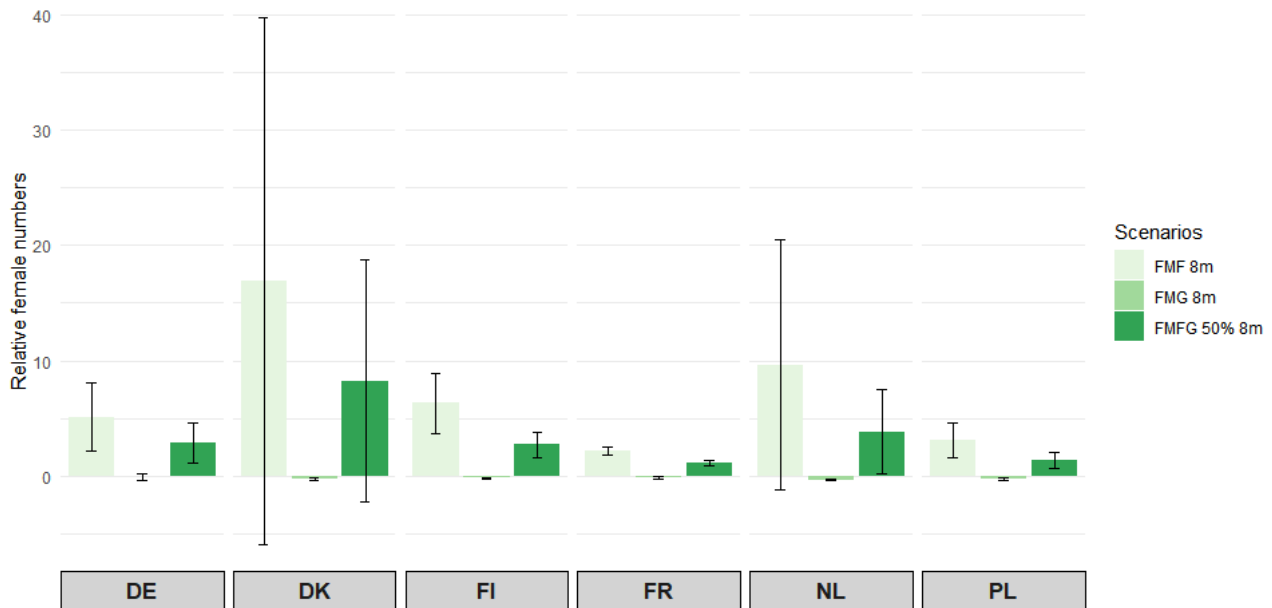


Figure 65 *M. agrestis* flower, grassy and mixed 8m margins bar chart showing the relative number of female *M. agrestis* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

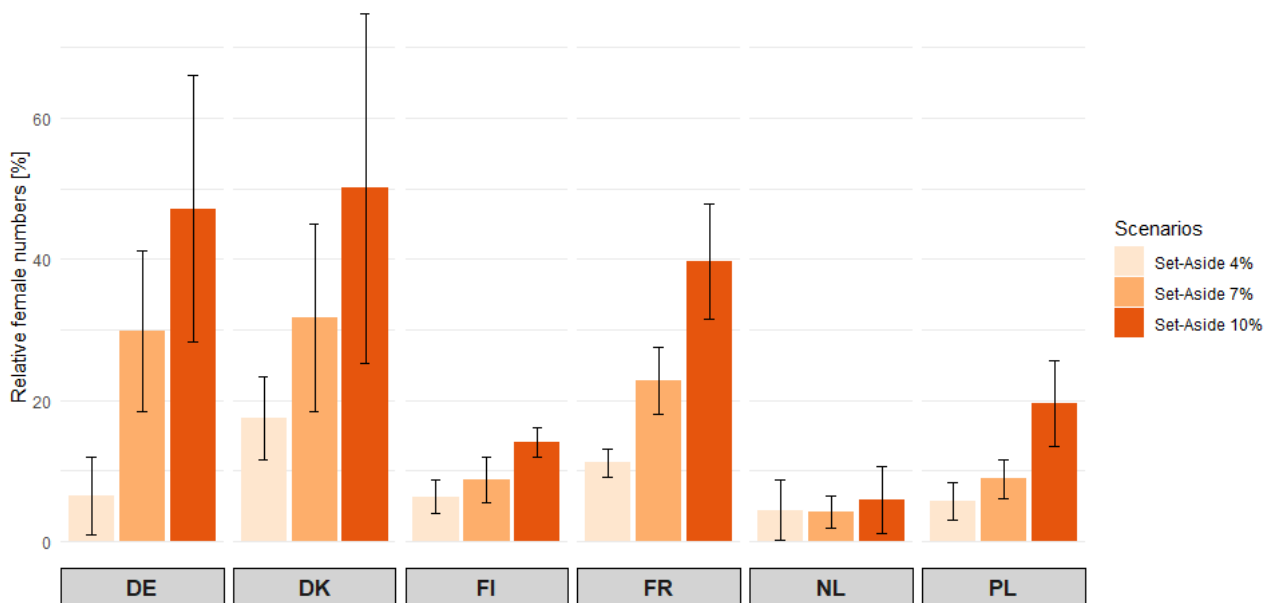


Figure 66 *M. agrestis* set-aside bar chart showing the relative number of female *M. agrestis* in each country compared to the baseline including standard deviation (SD).

3.3 Effectiveness of individual measures across species and landscapes

3.3.1 Diversification

The diversification scenario attempted to make the crops present within the landscapes more diverse. However, the crops grown were already quite diverse. Therefore, in this scenario we made the most commonly represented crops in terms of how many years they would be grown out of one-hundred years, less common and those planted less frequently more common. The number of crops did not change, but within a landscape, less common crops would cover more of the landscape in any given year. For some species this meant that crops that are beneficial to the species covered more of the landscape, but for others preferred crops, or crops with preferred managements were less present (Figure 67). Two examples of this are the bee, *Osmia*, which did marginally better with diversification, potentially due to a diversity of flowering crops and skylark, which may have been disturbed or not had access to fast growing crops in these diversification scenarios. Even among the aphid species, diversification had a different effect for the species and in particular landscapes. English grain aphids did worse, in line with our goal of reducing aphids in the landscape in all landscapes. Whereas pea and peach potato aphids benefited from diversification, and would therefore be a bigger pest, although likely only of the new crops (Figure 68) as most of the aphids are in the fields as can be seen in Figure 67 as there is little significant difference between those in the fields and landscape. The apparent improvement in the aphid scenario is likely simply due to us removing preferred crops and adding non-host crops. It is worth noting in general that in some cases the change caused by diversification was not significant for a particular landscape, country or species, this can be seen by exploring the appendices (2-10) for individual species and countries.

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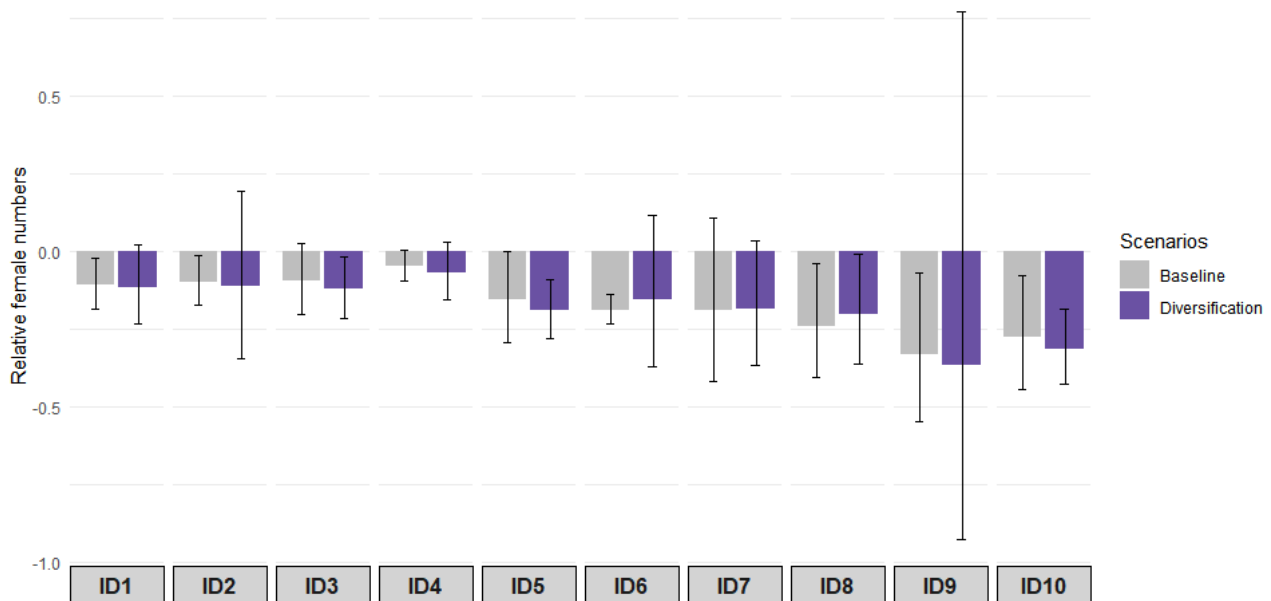
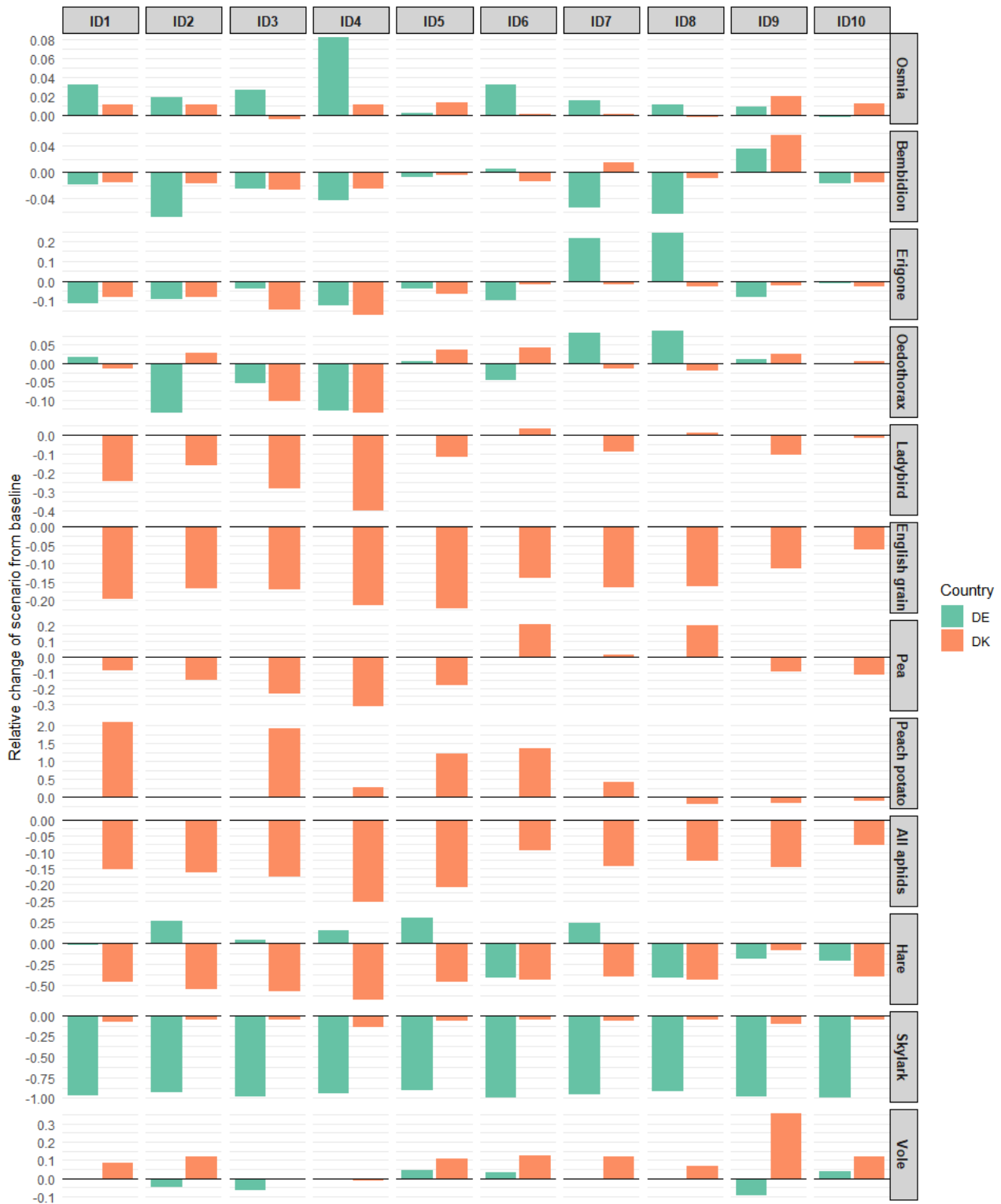


Figure 67 In-field relative to whole landscape comparison of pea aphid diversification runs in Danish landscapes. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.



3.3.2 Field margins, set-aside and legumes

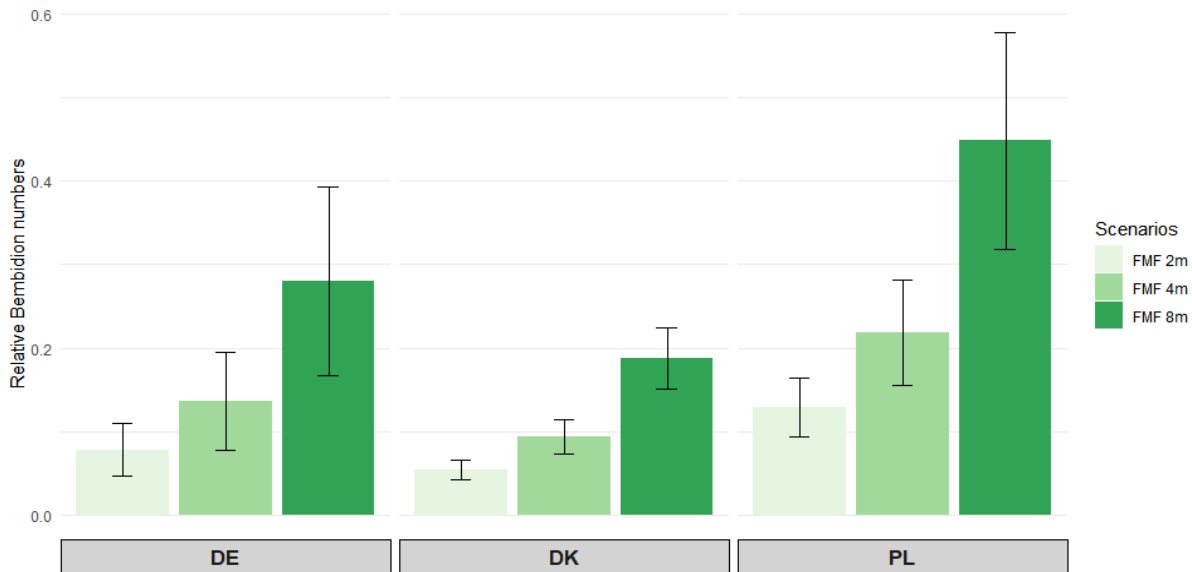
The addition of field margins or the setting aside of arable land as set-aside or as a legume crop, directly affected the area of arable land (Table 14). Roughly analogous, 2m field margins require a similar area of land (3.9%) as setting aside 4% of crop land, 4m (6.8%) similar to 7% and 8m (13%) to 10% (the analogy is less close). Across species, field margins had the most positive effect. In particular flowering field margins had a much more positive effect for the area than grassland, having twice the effect. Set-aside had a positive effect, but not to the same degree, more similar to that of the grassland field margins. In general, the legumes scenario had the weakest effect. In terms of scenario combination, the different field margins cannot be combined. It is also assumed that set-aside and legumes would not be combined. But it is possible if scenarios were considered separately for different landscapes, different scenarios could be chosen in different landscapes.

Table 14 Relative reduction in arable area for each area changing scenario, and the mean impact on all species relative to the baseline scenario.

Scenario	Relative Arable change	Relative species abundance to baseline
Diversification	0.00% (SD 0.00%)	-0.11
FMF 2m	3.90% (SD 0.35%)	0.44
FMF 4m	6.80% (SD 0.62%)	0.77
FMF 8m	13.00% (SD 1.20%)	1.56
FMG 2m	3.90% (SD 0.35%)	0.28
FMG 4m	6.80% (SD 0.62%)	0.41
FMG 8m	13.00% (SD 1.20%)	0.75
FMFG 50% 2m	3.90% (SD 0.35%)	0.36
FMFG 50% 4m	6.80% (SD 0.62%)	0.57
FMFG 50% 8m	13.00% (SD 1.20%)	1.17
Set-Aside 4%	4.00% (SD 0.00%)	0.27
Set-Aside 7%	7.00% (SD 0.00%)	0.48
Set-Aside 10%	10.00% (SD 0.00%)	0.72
Legume 4%	4.00% (SD 0.00%)	0.04
Legume 7%	7.00% (SD 0.00%)	0.05
Legume 10%	10.00% (SD 0.00%)	0.10
Biopesticide 80%	0.00% (SD 0.00%)	0.04
Biopesticide 90%	0.00% (SD 0.00%)	0.06
Biopesticide 95%	0.00% (SD 0.00%)	0.06
Biopesticide 100%	0.00% (SD 0.00%)	0.07

3.3.2.1 Flower Field Margin (FMF)

The flower field margin scenario had the most positive effect on our objectives for all species with the exception of ladybirds in Germany. This is likely because of the large reduction in aphid numbers driving ladybird populations down. In all cases wider margins were more effective than narrower margins, but this did not scale in the same way between species. For *B. lampros* for example, the effect scaled in a similar way to the increase in margin width (Figure 69), whereas for voles the increase with wider margins scales with percentage reduction in arable area or even greater (Figure 70). For voles, this is because with wider strips they are able to establish territories (Topping et al., 2003c). When looking at all species across countries, we therefore have elected to show the 8m flowering field margins here (Figure 71).



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Figure 69 *B. lampros* flower margins bar chart showing the relative number of female *B. lampros* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

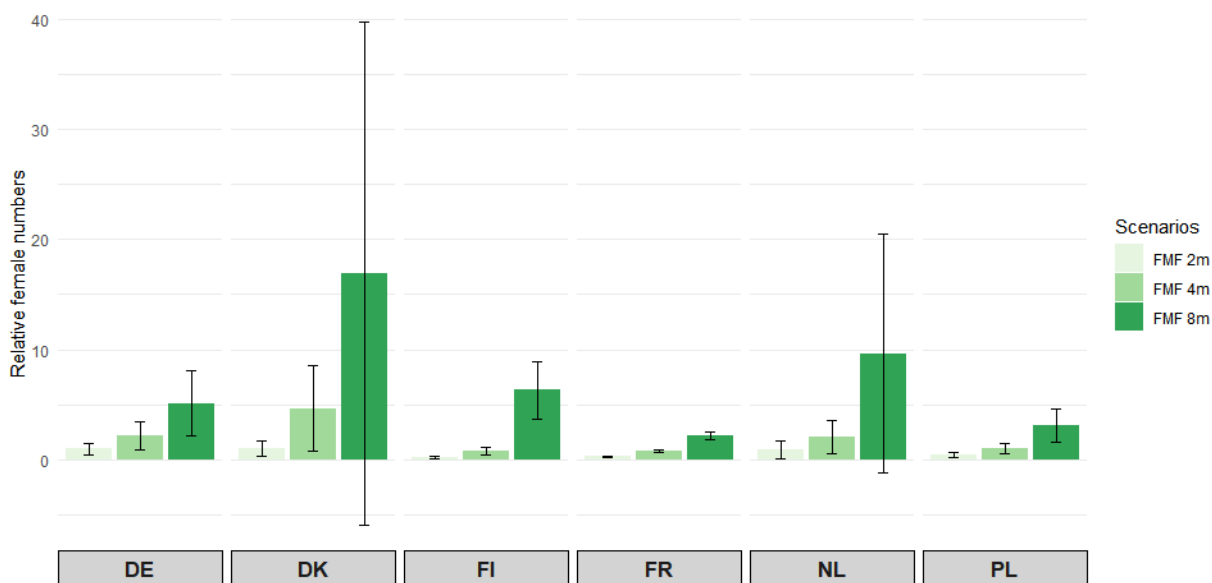


Figure 70 Vole flower margins bar chart showing the relative number of female Voles in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

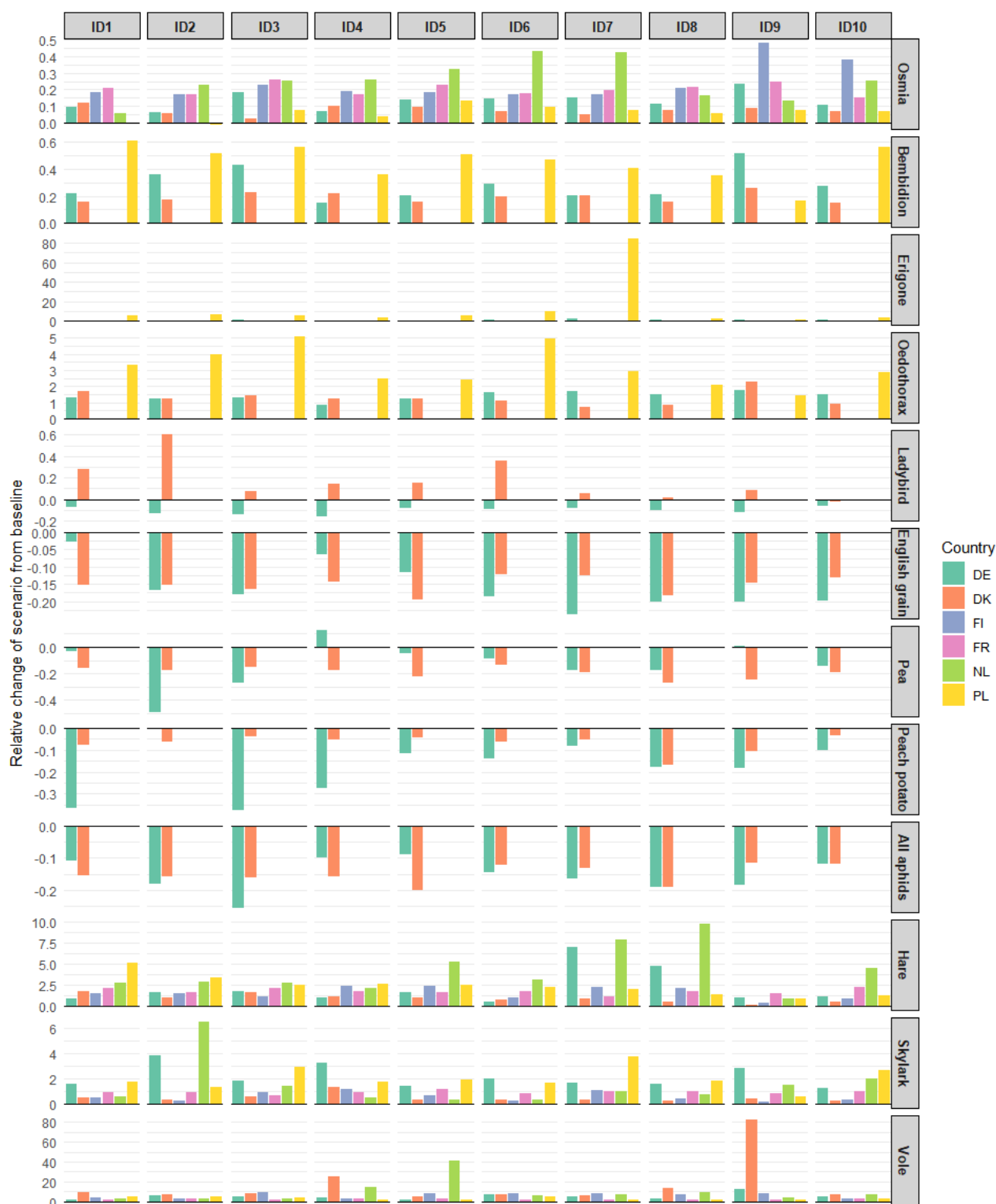
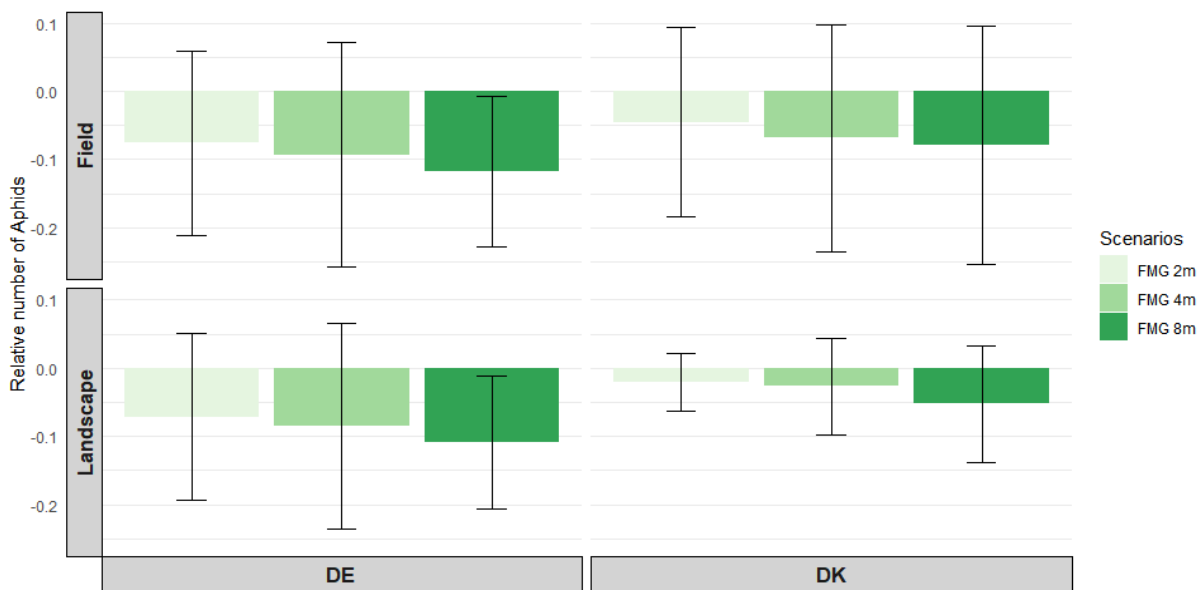


Figure 71 Relative change in the population of the 8m Flower Field Margin scenario compared to the baselines.

3.3.2.2 Grassy Field Margin (FMG)

Grassy field margins, in a similar way to flower field margins, did not scale in the same way between species, for example here we show black bean aphid where the aphids are reduced in a similar way to the reduction of arable land (Figure 72), but for skylark where skylarks increase, the relationship is more closely related to the width of the strip (Figure 73). Additionally for skylarks, grassland did not always have a positive effect, in the case of skylark because in small fields the reduction in caused by the field margin makes the field too small to provide nesting habitat despite the added foraging area. This effect was mirrored more widely for all of the species (Figure 74). Ladybirds and aphids were both reduced, in-line with our objective of reducing aphids. Osmia did less well in general, replacing flowering crops with non-flowering grassland. Voles also did less well, but all other species, generally benefited from grassy margins.



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Figure 72 Black bean aphid grassy margins bar chart showing the relative number of aphids in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

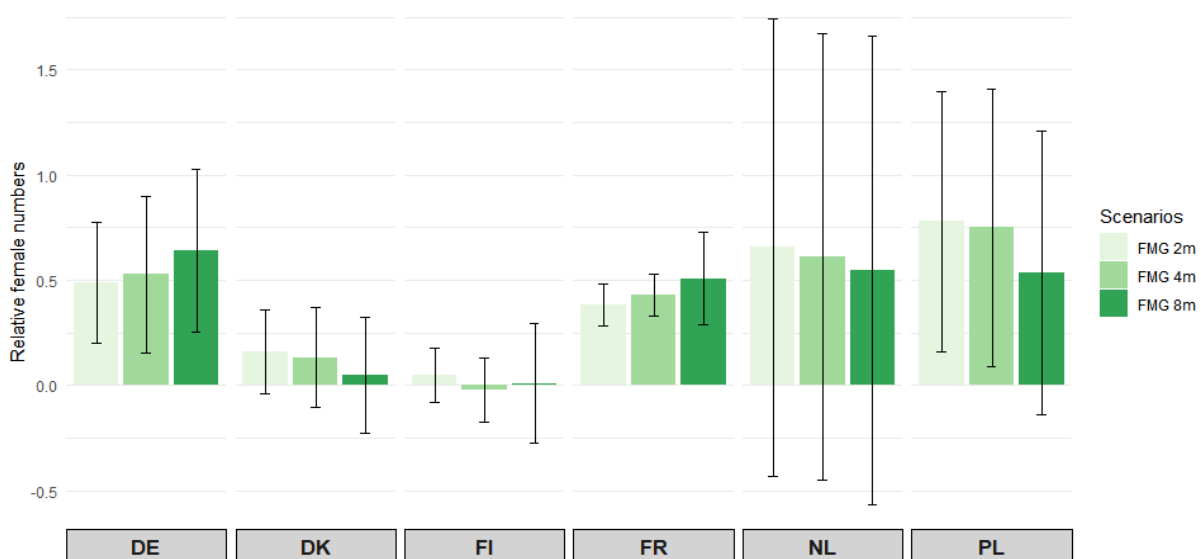


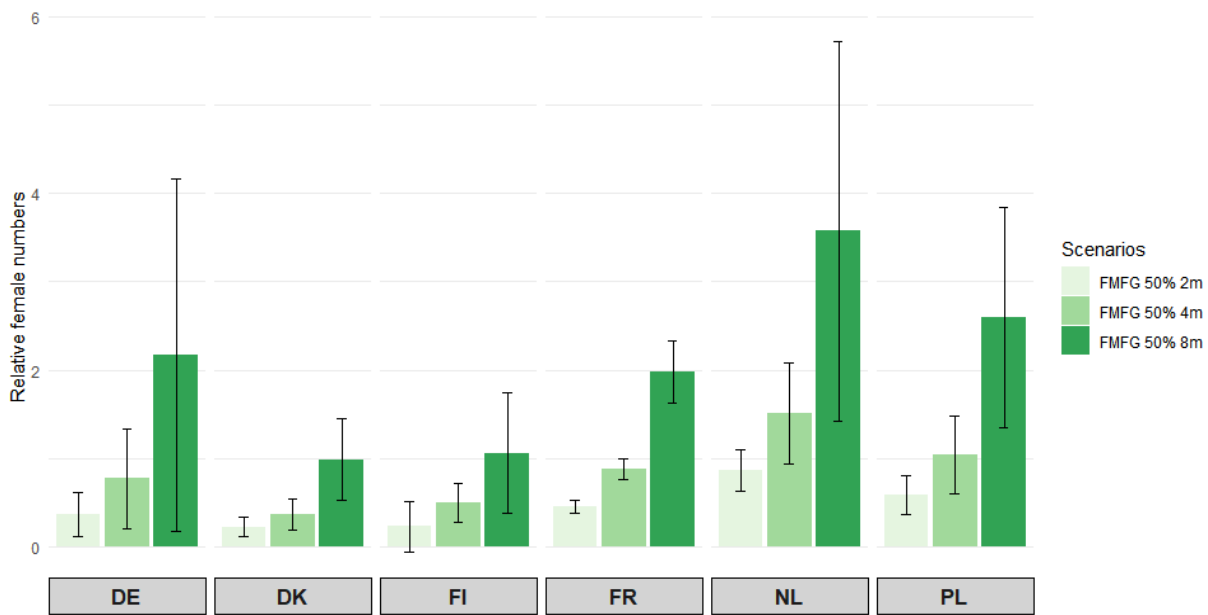
Figure 73 Skylark grassy margins bar chart showing the relative number of female Skylarks in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.



Figure 74 Relative change in the population of the 8m grassy field margin scenario compared to the baselines.

3.3.2.3 Grassy and Flower Field Margins (FMFG 50%)

In all cases, a 50:50 mixture of grassland and flowers was somewhere between the flowering field margins and grassland field margins. Overall, the flowering field margins were better for most species, but where a species had done less well with flowers, like the hare, with the mixture they did almost as well as with grass (Figure 75). Where the species had done well with flowers, they did almost as well with the mix. In all cases wider strips achieved more, but it was not always by a large margin as in the case of skylark (Figure 76). In many ways the mixed flowers and grass are the most all-round best in terms of fewest detrimental effects but going less far in achieving larger single or majority species gains.



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Figure 75 Hare flower & grassy margins bar chart showing the relative number of female Hares in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

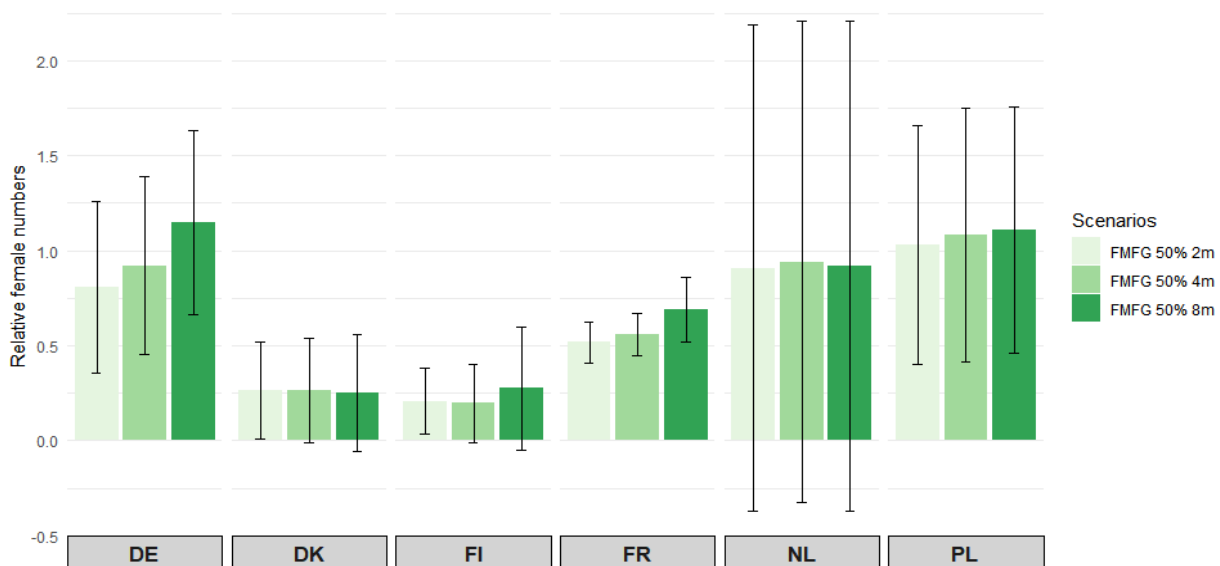


Figure 76 Skylark flower & grassy margins bar chart showing the relative number of female Skylarks in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.



Figure 77 Relative change in the population of the 8m grassy and flower field margin scenario compared to the baselines.

3.3.2.4 Set-aside

In almost all cases, set-aside scales closer to the area change (examples from hare and all aphids; Figure 78 & Figure 79). The set-aside scenario achieves more with a larger area and therefore we have given the example of the 10% set-aside scenario in this section when comparing across species and landscapes. In all cases, set-aside is a universal improvement in our objectives of pest control and increasing biodiversity.

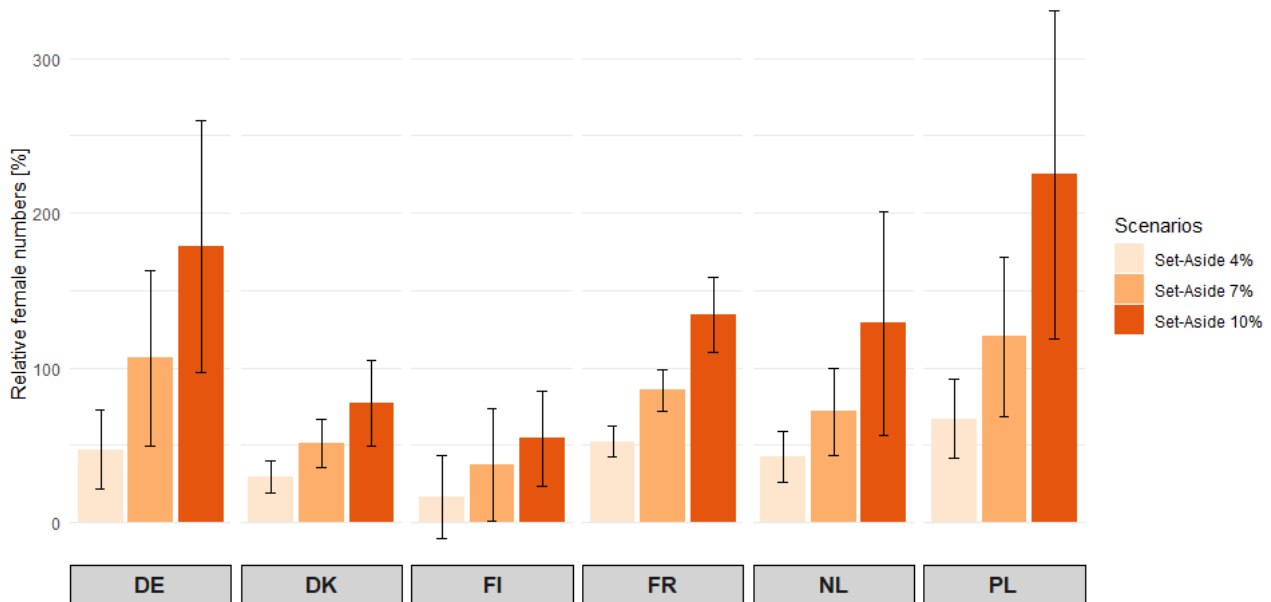


Figure 78 *L. europaeus* set-aside bar chart showing the relative number of female *E. atra* in each country compared to the baseline including standard deviation (SD).

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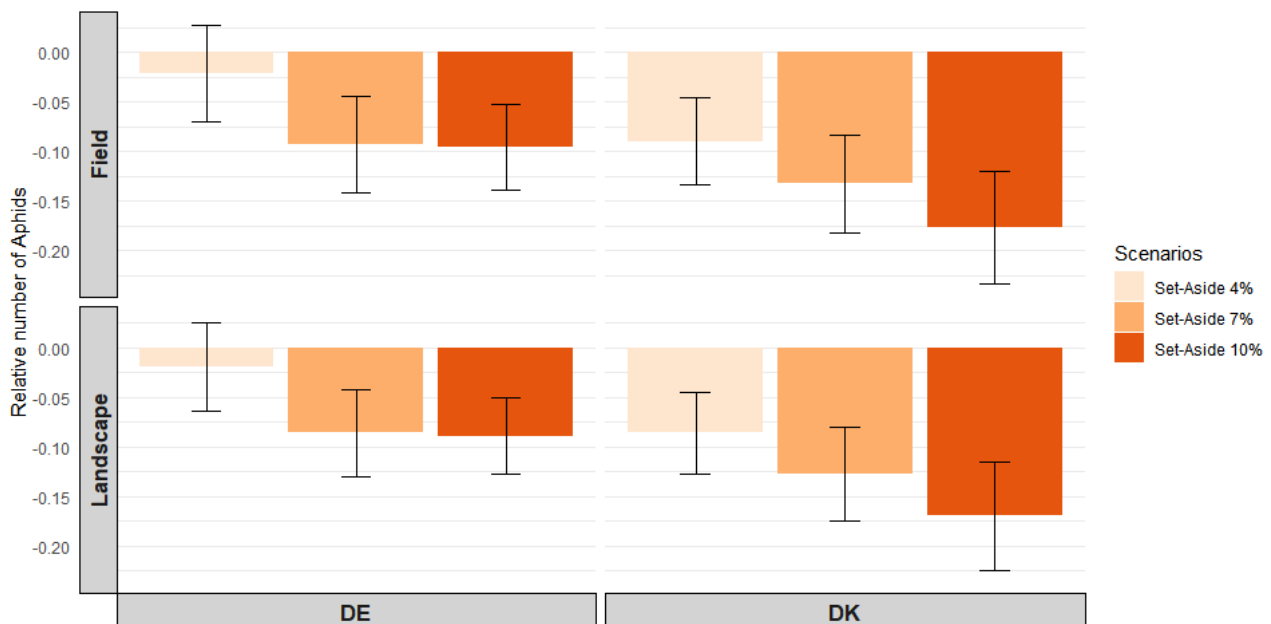


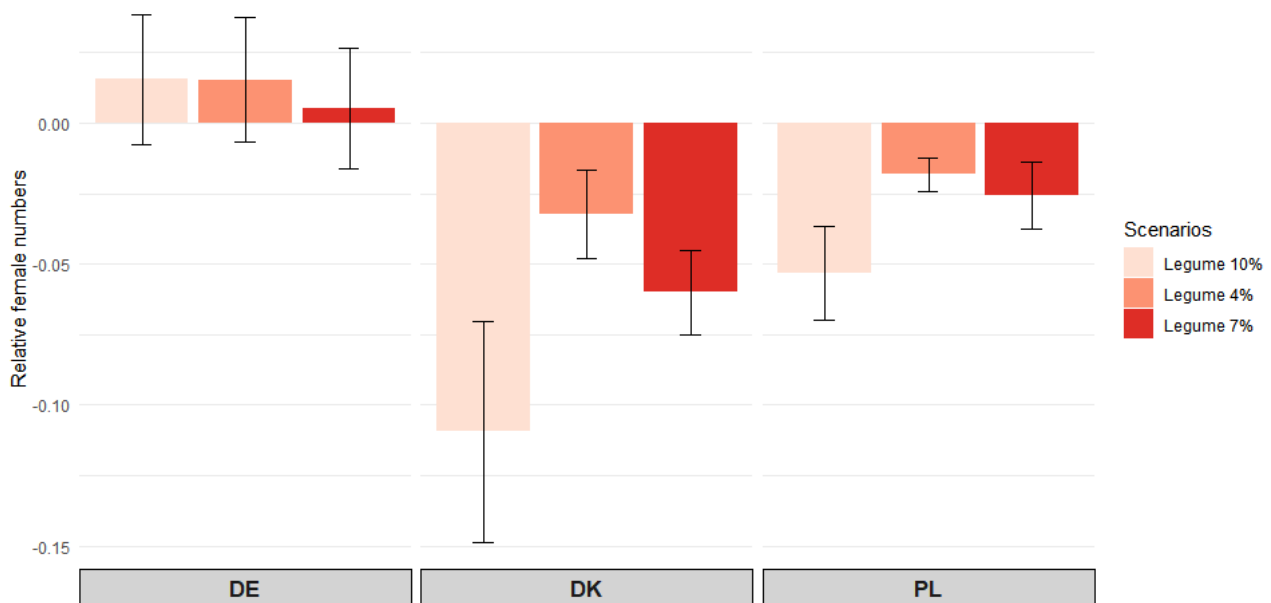
Figure 79 All aphids set aside bar chart showing the relative number of aphids in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.



Figure 80 Relative change in the population of the 10% set-aside scenario compared to the baselines.

3.3.2.5 Legume

For most species, legumes were not a helpful addition to the landscape. The only case where legumes were generally beneficial were the hares, and even for *L. europaeus*, they were not useful in all countries, having no real affect and potentially a negative effect in Finland (Figure 59). For a few of the other species, like *B. lampros*, they were very mildly beneficial in one or a few countries, but the effect size was very small (3% increase with 10% legumes for *B. lampros*) (see appendix 3 on *B. lampros*). For other species, scenario had a negative effect in some countries, such as *O. fuscus* where it could reduce the population by up to 10% (Figure 81). This different effect by species and country is a why we need to perform multi-criteria analysis to determine which scenarios best meet a given objective. The aphids were potentially reduced a very small amount by legumes, but only in Germany, whereas in Denmark they were increased by a similar small amount (see appendix 7 on aphids).



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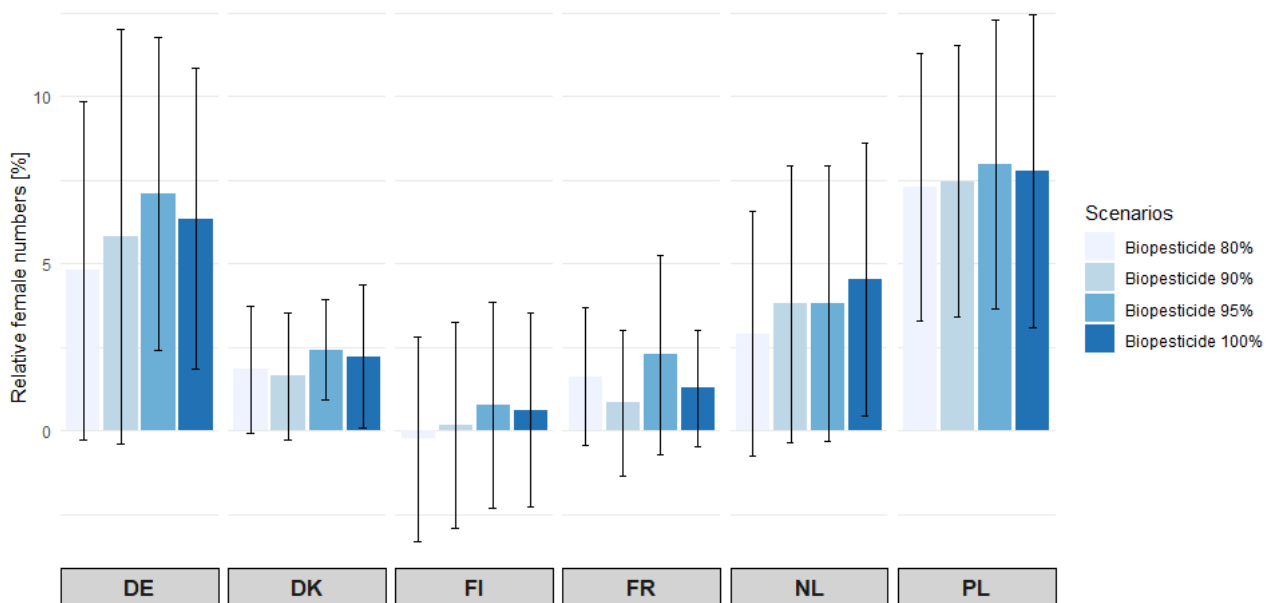
Figure 81 *O. fuscus* legume bar chart showing the relative number of female *O. fuscus* in each country compared to the baseline. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.



Figure 82 Relative change in the population of the 10% legume scenario compared to the baselines.

3.3.3 Biopesticides

Biopesticides were implemented slightly differently for different species (see subsection 2.9.5 Biopesticides). For hares and voles the biopesticide had no effect. Skylarks themselves were unaffected by biopesticides (Figure 83), but the arthropods they consume were affected, although affected less with the increasing percentage of biopesticides. This had a small effect then on skylarks themselves, although varying between countries (Figure 83). The effect with the current implementation of pesticides on *Osmia*, was to have not significant effect. Aphids were killed in exactly the way they were previously, so ladybird should have not experienced a negative impact from biopesticides, but despite experiencing less lethal effects, the ladybird population were not significantly impacted by any of the levels of biopesticide (see appendix 6). The other arthropods, beetle and spiders, were positively impacted (Figure 84) with the most benign biopesticide to non-target species having the greatest effect (*E. atra* as an example in Figure 44, Figure 45).



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Figure 83 *A. arvensis* biopesticide bar chart showing the relative number of female *A. arvensis* in each country compared to the baseline including standard deviation (SD).

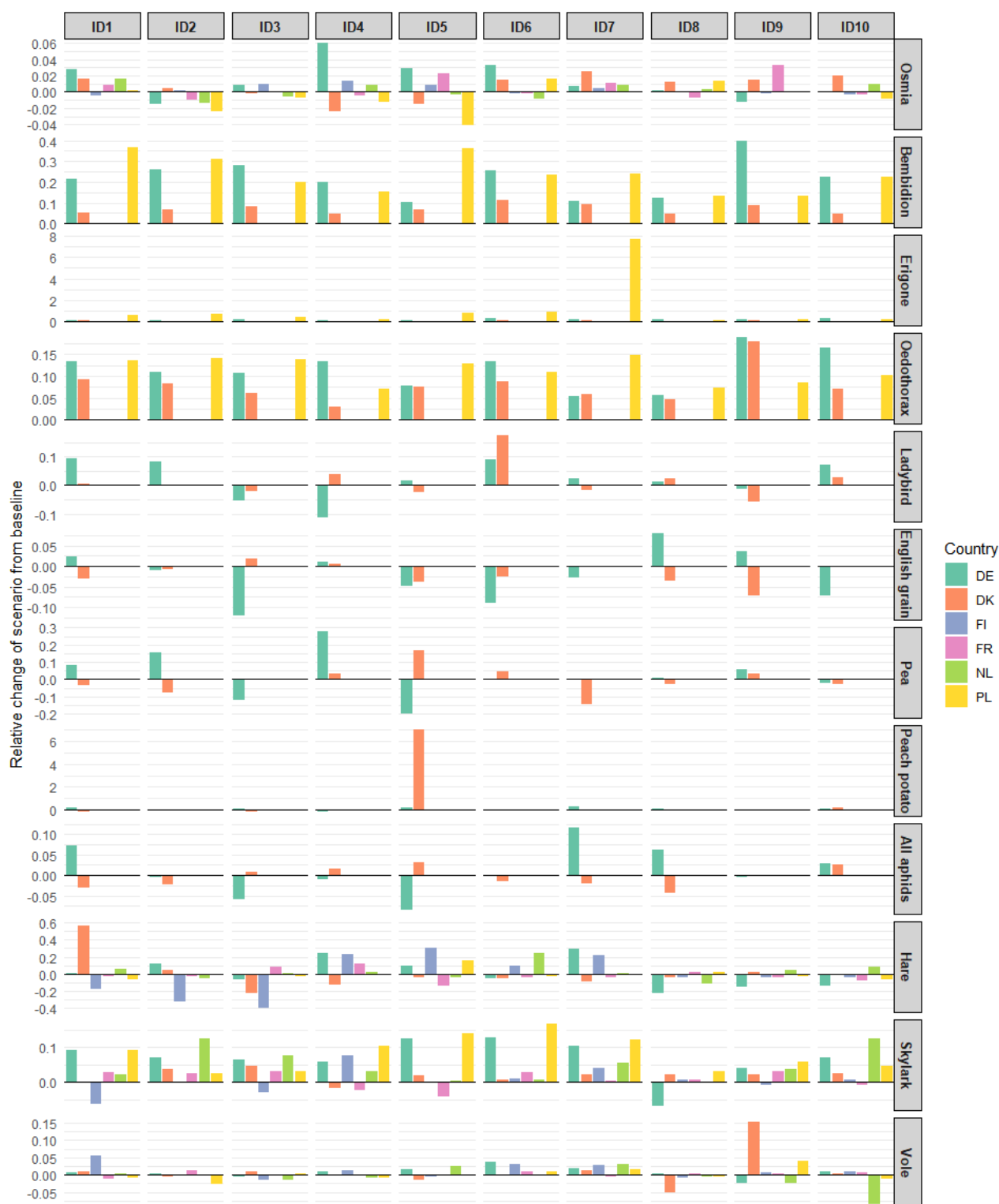
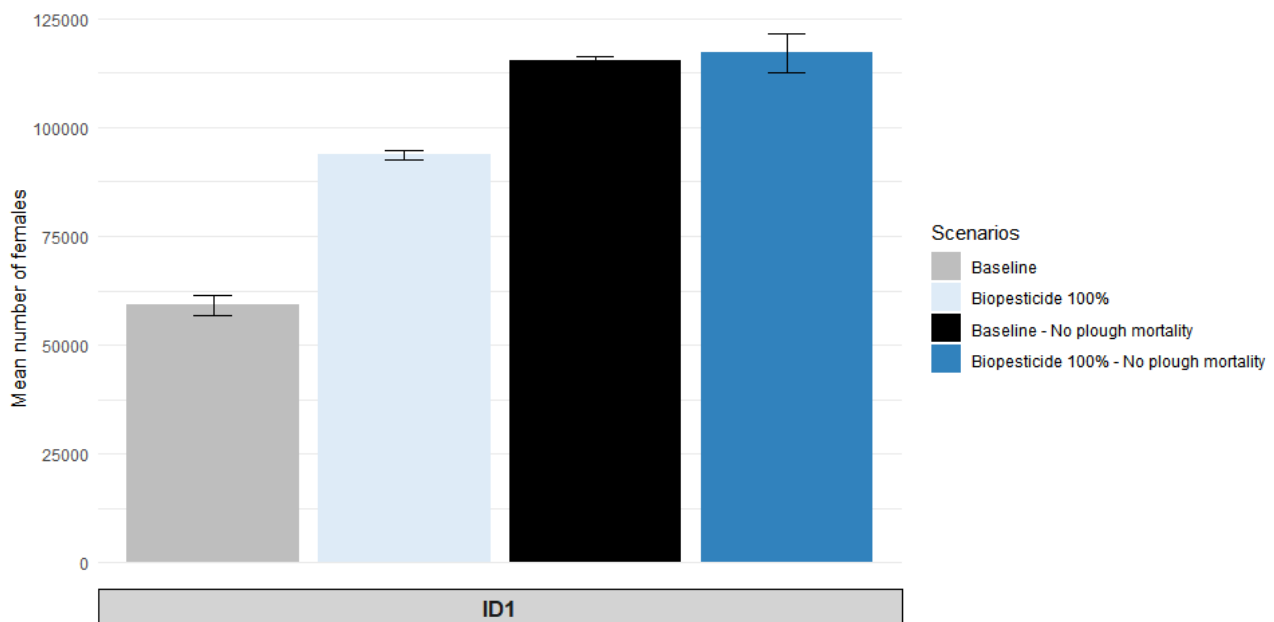


Figure 84 Relative change in the population of the 100% biopesticide scenario compared to the baselines.

3.3.4 Alternative no plough scenario

An alternative scenario that we did not generally run was to explore reducing ploughing as ploughing is deadly to many species. In some cases, other scenarios may not have as much of a positive effect if the species was already being decimated by ploughing. We assumed biopesticide should have an even more positive effect. We therefore ran an example scenario where we made ploughing entirely non-lethal for *E. atra*. This is unrealistic, as it is not a reduced ploughing, but it does show the effect of ploughing. The results can be seen in Figure 85. Surprisingly, this did not make biopesticides more effect, likely because number of *E. atra* in fields can reach near maximum values when they are not disturbed by ploughing. Ploughing mortality was explored by Topping et al. (2009) for our two spider species *E. atra* and *O. fuscus* where they showed that with background farm agricultural activity mortality, pesticides had a much greater affect, as the population had already been reduced killing of those individuals which would have been affected by density dependent mortality. Without ploughing, pesticides kill many that would die due to density dependence, whereas with an already reduced population, the pesticide is killing a larger proportion of the individuals that remain.



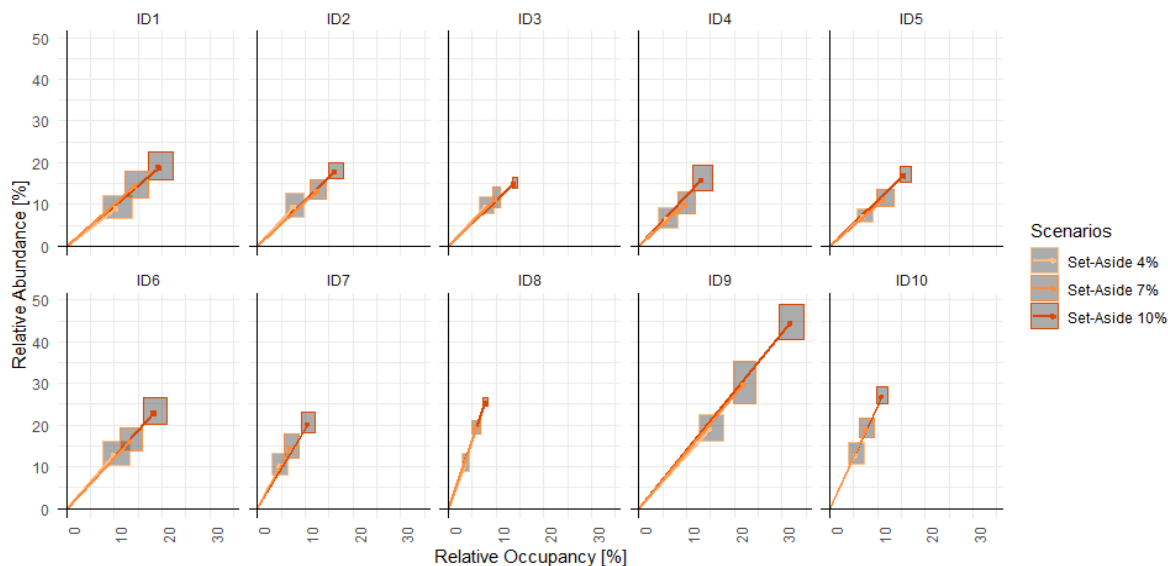
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Figure 85 An example case for *E. atra* showing the effect of ploughing mortality. The figure shows the baseline population for one landscape, the best biopesticide scenario, the baseline with ploughing mortality removed, and the biopesticide scenario with ploughing mortality removed. With no ploughing mortality, biopesticide cannot increase the population further as the model is approaching the carrying capacity of the farming landscape. Error bars show the standard deviation of the repetitions of simulation runs and landscapes.

3.3.5 Abundance Occupancy Ratio (AOR) plots

The AOR plots provide a more detailed picture of changes in animal populations due to landscape-scenario impacts. AOR plots show the change in relative abundance on the y-axis, which is the change in density of the species where it is present in the landscape. On the x-axis, the change in proportion of the landscape occupied by the species is shown. Here, we present a selection of results demonstrating one or more aspects of the results.

Figure 86 shows a rare example of a perfect relationship between scenario strength and effect. This plot, for *O. fuscus*, shows that for an increase in the set-aside area there is a predictable increase in the population density and its distribution in the landscape. There is minimal variation between landscapes in the response, with a 10% increase in set-aside resulting in a 20-30% increase in the abundance score and a 20% increase in occupancy. Compare this to Figure 87; this is the same species, country, and landscapes, but the scenario has 8m margins under different management. Here, the results are also clear, with the 8m margin of all types conferring a benefit in occupancy of the same size but with a better performance of the flower margins compared to grassy margins or a mix thereof in terms of occupancy.



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Figure 86 Set-aside scenario with the relative change in occupancy and abundance of female *O. fuscus* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

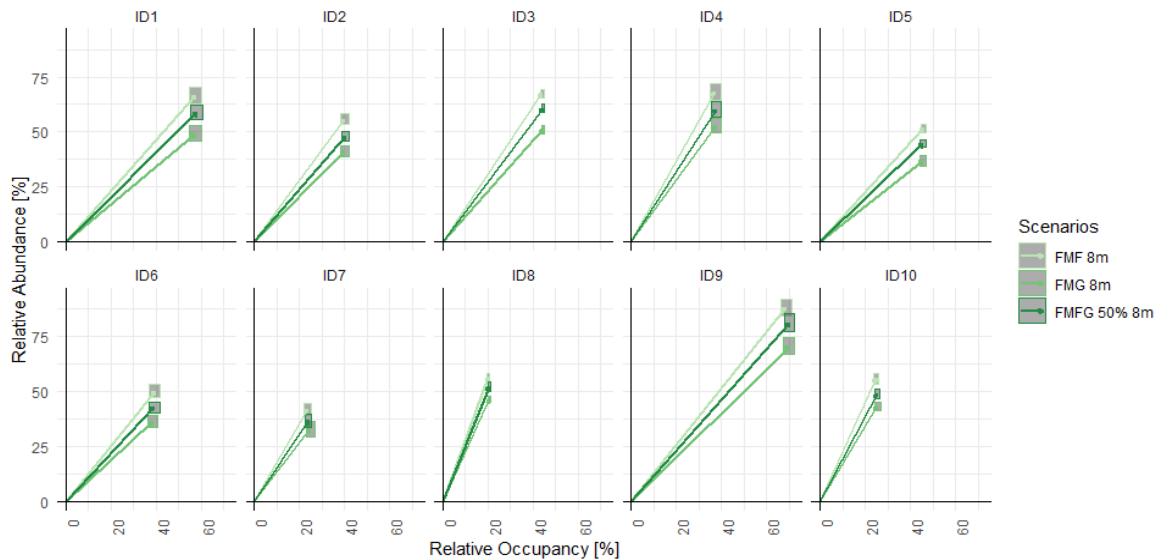


Figure 87 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with the relative change in occupancy and abundance of female *O. fuscus* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

Figure 88 and Figure 89 show the responses of *O. bicornis* and *B. lampros* to three widths of flower margins. Here, responses are more complex than the *O. fuscus* cases. In the case of *O. bicornis*, there is a big positive effect of the 2m margin, but wider is neither better nor worse. The effect varies between landscapes slightly, but occupancy is not affected (0-2%), whereas abundance impacts show an increase of 5 to 15%, varying between landscapes within this narrow range.

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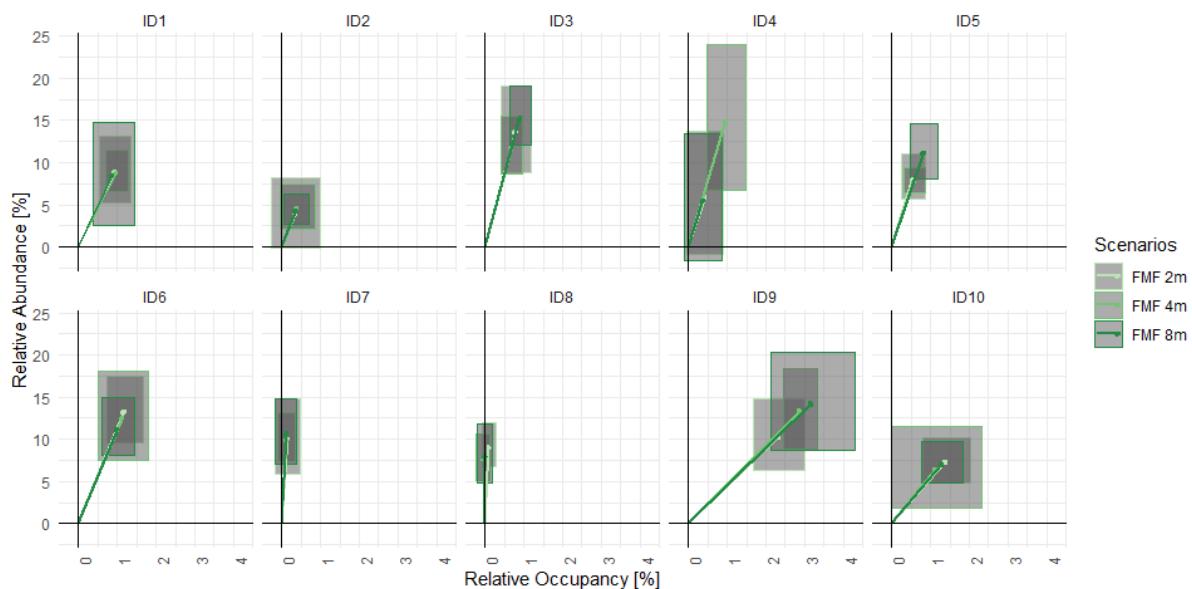
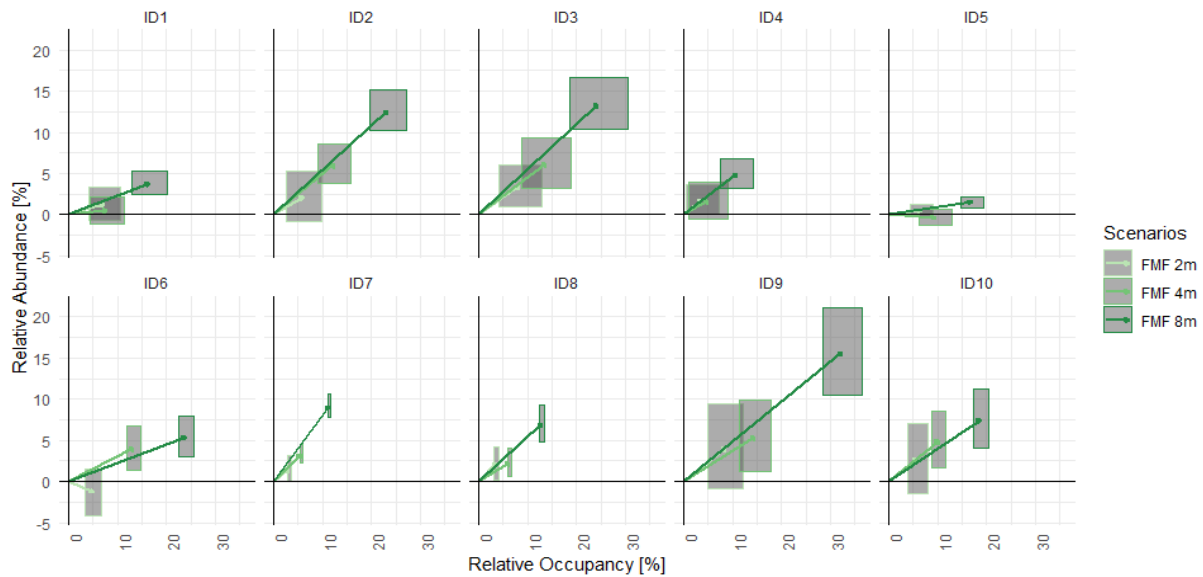


Figure 88 Flower field margins with the relative change in occupancy and abundance of female *O. bicornis* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

For *B. lampros*, the picture is rather different. Here, occupancy was affected to a much greater extent, up to 30%, with the effect clearly being larger with the larger margins. In ID5 there was no significant change in abundance, whereas in other landscapes, up to 15% increase in abundance was observed. Hence, in ID5 we have only a range extension, whereas for ID9 we have both a range extension (increased occupancy) and habitat improvement (increased density). This complex pattern of landscape effects altering the overall picture is even more clear in *B. lampros* with the biopesticide scenario (Figure 90). Here, within scenario variation was minimal, and the effect of survival from biopesticides (80-100%) was clear, but in 3 out of 10 landscapes (IDs 5, 7 and 9), the effect was only on occupancy, even though the effect was high (up to 30%). In the other seven landscapes, occupancy increased by 5-10%, but abundance increased by 5-20%.



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Figure 89 Flower field margins with the relative change in occupancy and abundance of adult *B. lampros* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

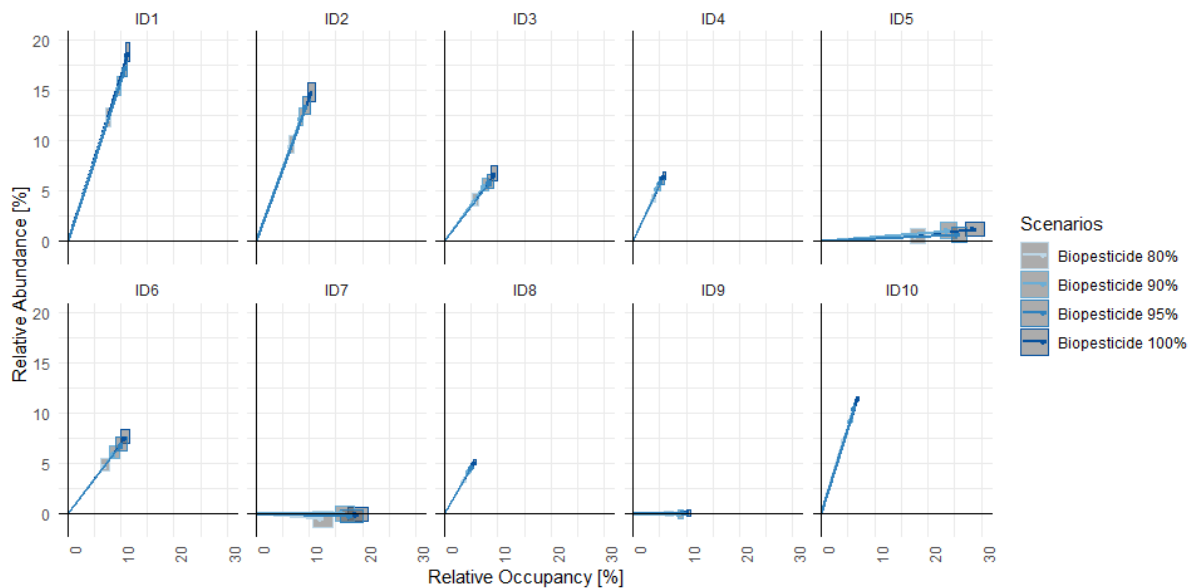


Figure 90 Biopesticide scenario with the relative change in occupancy and abundance of adult *B. lampros* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

In contrast to the *B. lampros* example, Figure 91 shows *L. europaeus* responses to grassy field margins. Here, 3 out of 10 landscapes had a strong bias to increasing abundance only, but with strong effects on occupancy for the other 7 landscapes. In this case, wider margins have a proportional impact on the AOR change.

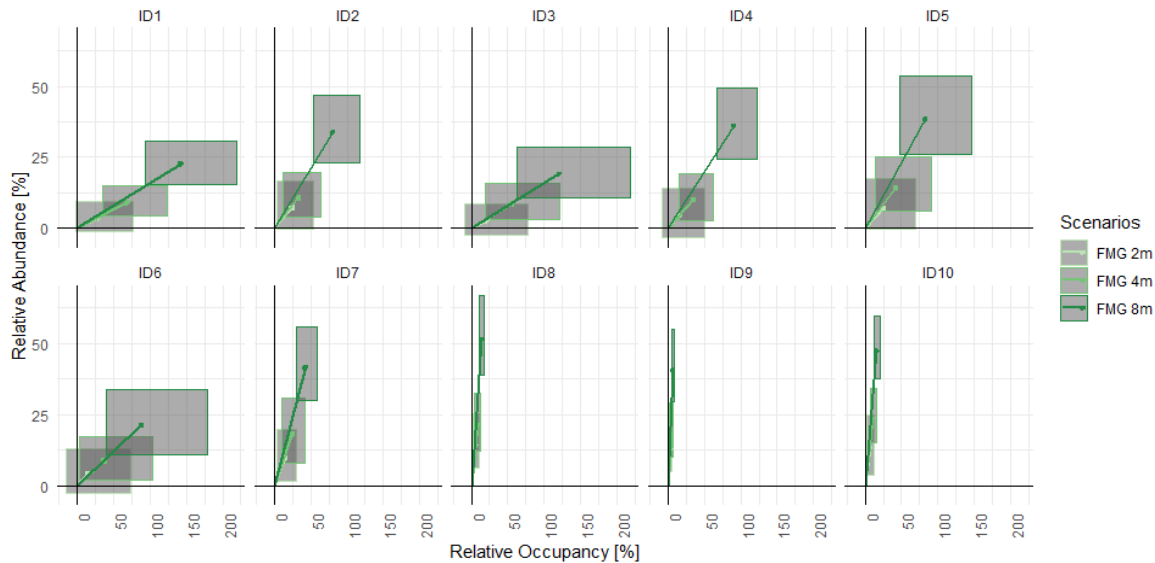


Figure 91 Grassy field margins with the relative change in occupancy and abundance of female *L. europaeus* compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

C. septempunctata and *A. arvensis* show two examples of negative effects of the scenarios (Figure 92 and Figure 93). In the case of the *C. septempunctata* and 8m margins all scenarios show an increase in abundance, but in almost all cases a large decrease in occupancy. This suggests a range contraction but is more likely to be linked to the changes in aphid distribution. In the *A. arvensis* example, the diversification scenario demonstrates a relatively small but negative impact on both abundance and occupancy.

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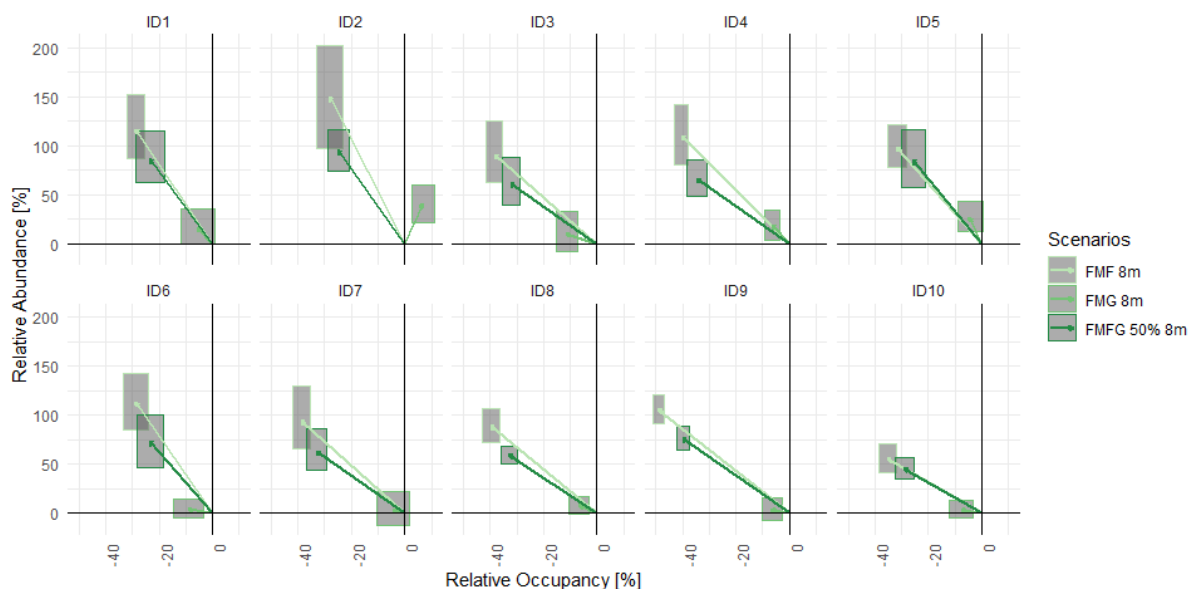


Figure 92 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with the relative change in occupancy and abundance of female *C. septempunctata* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

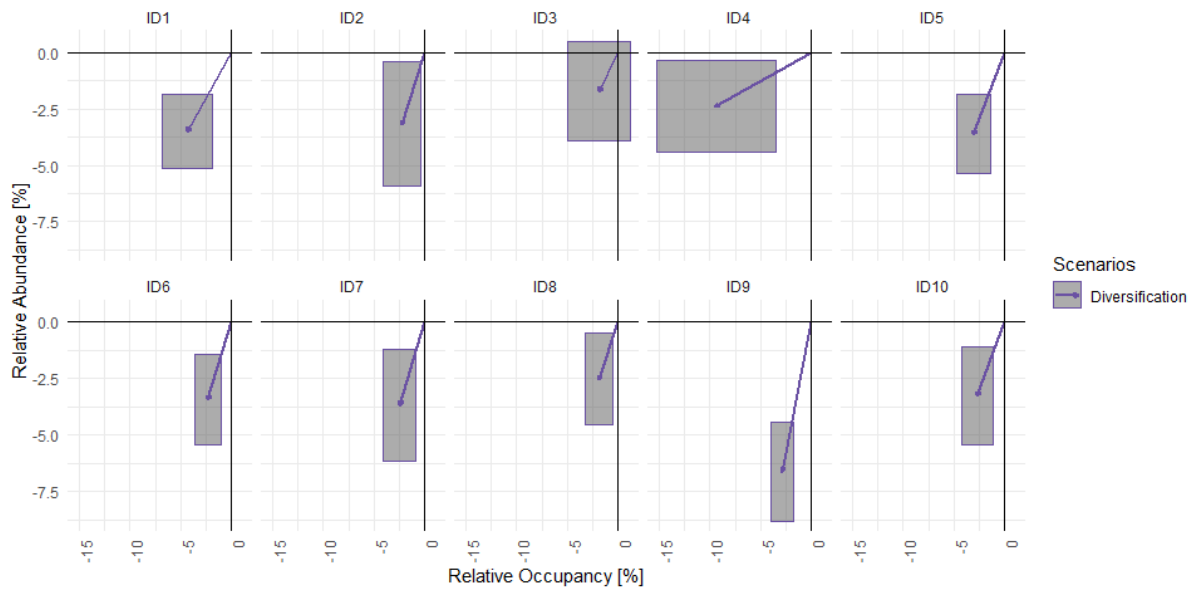


Figure 93 Flower field margins with the relative change in occupancy and abundance of female *A. arvensis* compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

One of the most complex responses can be seen in the *M. agrestis* response to flower margins. In Germany (Figure 94), there is a very large positive response in abundance to 8m flower margins, but a much lower response for the other two scenarios. Whereas occupancy with the 4m margin is almost as good as 8m. This relates to the different use of the habitat by the *M. agrestis*. When wide enough habitat can be used for breeding, hence an increase in abundance, but if narrow it can still be used as a corridor, resulting in better dispersal and an increase in occupancy. Figure 95 show the same scenario for Denmark. Here the picture is the same but more extreme, with the 2m scenario increasing occupancy and decreasing abundance. ID9 is a clear outlier. In ID9 the baseline conditions were very poor for *M. agrestis*, with a very small population, hence the only significant increase here is when 8m margins are used and the habitat is suddenly massively extended, resulting in large positive changes in AOR scores. This outlier is useful to demonstrate the point about habitat extension but inflates the overall mean effect of the 8m scenario in Denmark and underrepresents the effect of the 2 m and 4m scenarios.

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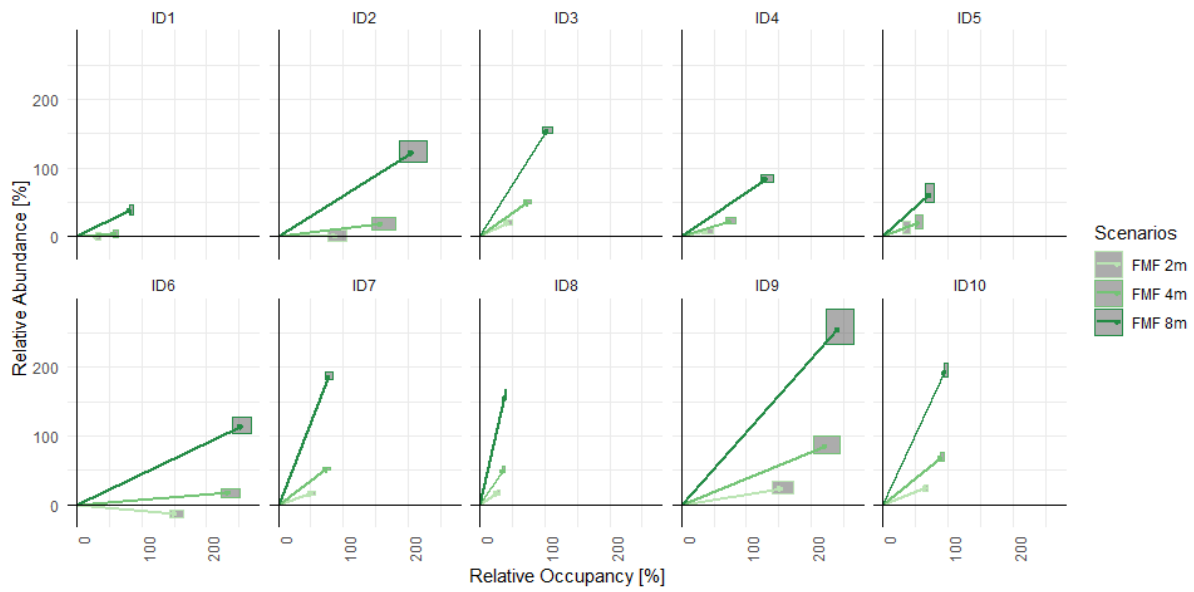


Figure 94 Flower field margins with the relative change in occupancy and abundance of female *M. agrestis* compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

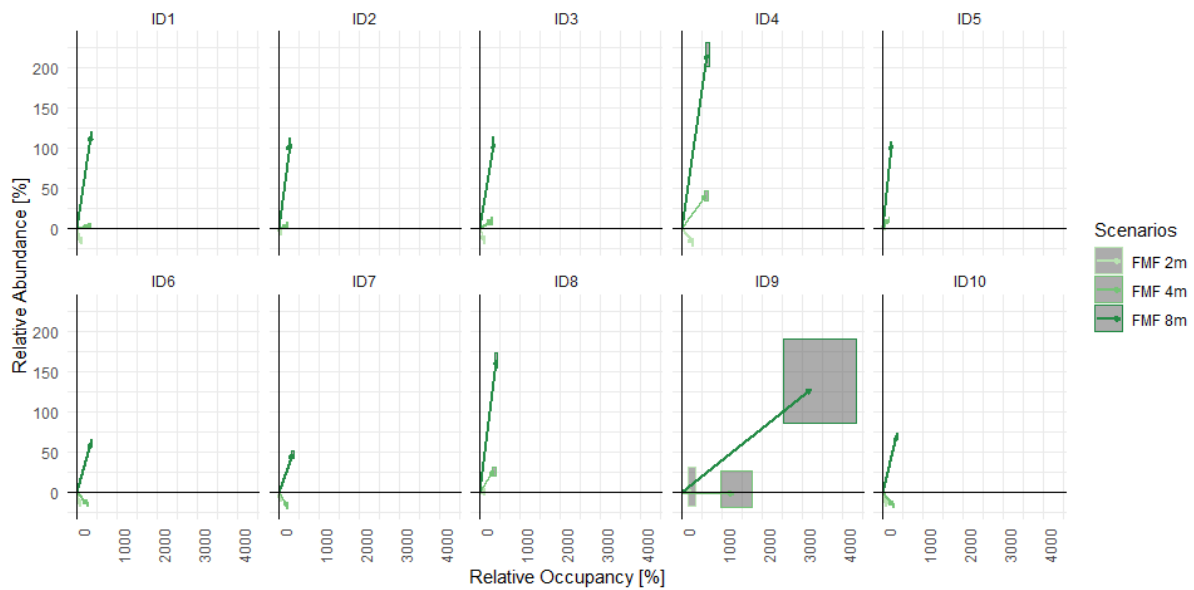


Figure 95 Flower field margins with the relative change in occupancy and abundance of female *M. agrestis* compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

3.4 Summary of scenario results

Across all species, field margins had the most positive effect, although the optimal type varied slightly among species. Flowering field margins were most beneficial for the majority of species, with the exception of hares. Grassland field margins had a detrimental effect on *Osmia*, likely due to the removal of flower resources found within fields but were generally neutral for other species. Fifty-fifty mixes of flowers and grass served as a middle-ground scenario, proving almost as effective as pure flower margins, particularly for flower-loving species.

Set-aside emerged as the next best single scenario across all species, exhibiting more universally positive effects. Biopesticides were generally positive for all species, except for voles and hares, on which they had no discernible impact. In all cases, a larger extent was associated with better outcomes – wider strips, a larger proportion of set-aside, and the use of biopesticides with the least lethal effect on non-target animals, the focal species in this study.

When considering the impact per unit area, flowering field margins yielded the best results, followed by set-aside (see Figure 72). The relationship with area, however, varied among species. Increasing bars in Figure indicate that more is gained with increased area, while level bars suggest a linear relationship, and declining bars imply diminishing returns with larger areas. For instance, in the case of *Osmia*, a 2m margin provided the most impact per unit area, with little additional benefit from wider strips. Biopesticides, on the other hand, did not exhibit a significant impact on area, yielding only a small positive effect overall.



Figure 96 Relative change in species abundance caused by scenarios, divided by percentage area of arable land. The bars increase from left to right with 2m, 4m, or 8m for those scenarios beginning FM and 4%, 7% and 10% for the Legumes and Set-Aside.

3.5 Multi-criteria decision-making

The multi-criteria decision-making process combined the results of applying individual measures across species, landscapes, and countries (Table 15). In all tested weighting schemes in the multi-criteria decision process, the best performing scenarios were related to either field margins or set-aside measures. In most of the weighting schemes (except 'arable invertebrate'), the two most effective scenarios that clearly distinguished themselves from others were 8 m wide field margins either covered with flowers or 50% with flowers and 50% with grass. However, their advantage over other scenarios was somewhat reduced when the averaged relative changes in population numbers were scaled by an implementation cost ('arable' versus 'unweighted' weighting scheme). In general, most scenarios and weighting schemes followed the 'more is better' rule, i.e. the scoring of scenarios increased as the intensity of the measures applied increased. Interestingly, in most of the weighting schemes (again, except for 'arable invertebrate'), the 4 m wide flower field margins performed similarly to the 8 m wide grass field margins and the introduction of 10% set-aside in the crop rotations. In the 'arable invertebrates' weighting scenario, 8 m wide field margins with all cover types had similar effectiveness. Scenarios related to biopesticide application and increasing legumes in rotations were significantly less effective than field margins and set-aside scenarios in all analysed weighting schemes. The crop diversification scenario was the worst performing, with either a slightly negative effect or no effect (in the case of 'arable weighted invertebrate' scenario). In addition, there were very clear differences between the effectiveness of the scenarios for invertebrates and vertebrates, with the top-row scenarios being 3-4 times more effective for vertebrates than for invertebrates. For invertebrates, most scenarios were generally less effective than for vertebrates, with the exception of the biopesticide scenarios, which were clearly better for invertebrates.

Table 15 Unweighted mean relative change of species numbers for treatment scenarios compared to baseline scenario. The unweighted category is simply the mean of all species. Arable weights the means by the percentage reduction of arable land compared to the baseline. Arable Weighted Invertebrate combines *O. fuscus*, *B. lampros*, *E. atra* and aphids (aphids multiplied by -1) into a single group, by dividing all four, by four, and then combined with the pollinator score. Arable Invertebrate and Arable Vertebrate are the arable weighted species split into those two groups giving all species equal weight within each group. Greener values are positive changes, red values negative changes and yellow values around zero.

Scenarios	Weighting schemes				
	Unweighted	Arable	Arable Invertebrate	Arable Vertebrate	Arable Weighted Invertebrate
Diversification	-0.07	-0.09	0.01	0.01	-0.22
FMF 2m	0.36	0.34	0.05	0.10	0.58
FMF 4m	0.76	0.71	0.06	0.15	1.09
FMF 8m	1.94	1.68	0.08	0.25	2.83
FMG 2m	0.16	0.15	0.02	0.09	0.27
FMG 4m	0.26	0.25	0.04	0.14	0.4
FMG 8m	0.54	0.47	0.06	0.24	0.78
FMFG 50% 2m	0.26	0.25	0.05	0.11	0.42
FMFG 50% 4m	0.49	0.46	0.06	0.16	0.72
FMFG 50% 8m	1.28	1.11	0.08	0.26	1.78
Set-Aside 4%	0.19	0.18	0.02	0.06	0.34
Set-Aside 7%	0.41	0.38	0.03	0.12	0.62
Set-Aside 10%	0.6	0.54	0.04	0.16	0.92
Legume 4%	0.05	0.05	0.00	0.00	0.08
Legume 7%	0.09	0.08	0.00	0.00	0.13
Legume 10%	0.14	0.13	0.00	-0.01	0.22
Biopesticide 80%	0.03	0.03	0.01	0.04	0.01
Biopesticide 90%	0.04	0.04	0.02	0.06	0.00
Biopesticide 95%	0.04	0.04	0.02	0.06	0.01
Biopesticide 100%	0.05	0.05	0.02	0.06	0.01

3.6 Maximum-uptake stacking scenarios

Based on the results from the multi-criteria decision making, three scenarios (called ‘mitigation scenarios’) were selected to be included in the ‘maximum-uptake’ stacking scenarios. These were: flower strips of 8 m width (as being most effective among all field margin scenarios), introduction of 10% set-aside (as being much more effective than introduction of legumes and crop diversification scenarios) and implementation of 100% biopesticides. Three ‘maximum-uptake’ scenarios were run, firstly combining two of these scenarios (flower strips combined with set-aside and flower strips combined with biopesticides), while the third one combined all the three scenarios. Stacking scenarios were run for all countries and all species.

Below we first present results of applying the ‘maximum-update’ scenarios for different species, and then summarize effectiveness of ‘maximum-uptake’ scenarios across species, landscapes, and countries. Note that results are presented for different subset of countries. For the first part (section 3.6.1) results are presented based on all the available results for each species, for vertebrates and *Osmia* this includes all six countries, for invertebrates except ladybird and aphids only Denmark, Germany, and Poland, and for Ladybird and aphids only Denmark and Germany. To be comparable to component scenarios the effect of stacked scenarios was assessed on both a combination of Denmark and Germany (as these were the only countries with component scenarios for everything (Table 17) and for all countries when comparing only stacked scenarios, as results for these were available for all countries (section 3.6.2)

3.6.1 Species-specific responses to maximum uptake stacking scenarios

3.6.1.1 Pollinator ecosystem services

Between the three ‘maximum-uptake’ scenarios there were little difference in their effectiveness with an average positive population impact of 16% (Appendix 13, Table 13.1). However, the same effect could be obtained by the pure 8m flower strip scenario (Figure 73) indicating that the pattern seen for *Osmia* is largely driven by the food availability offered by flower strips. Of the individual component scenarios set-aside was slightly better than biopesticide (Figure 97). Seen from a pure pollinator perspective there is little gain from adopting multiple measures when similar effects can be achieved with one, namely flower strips.

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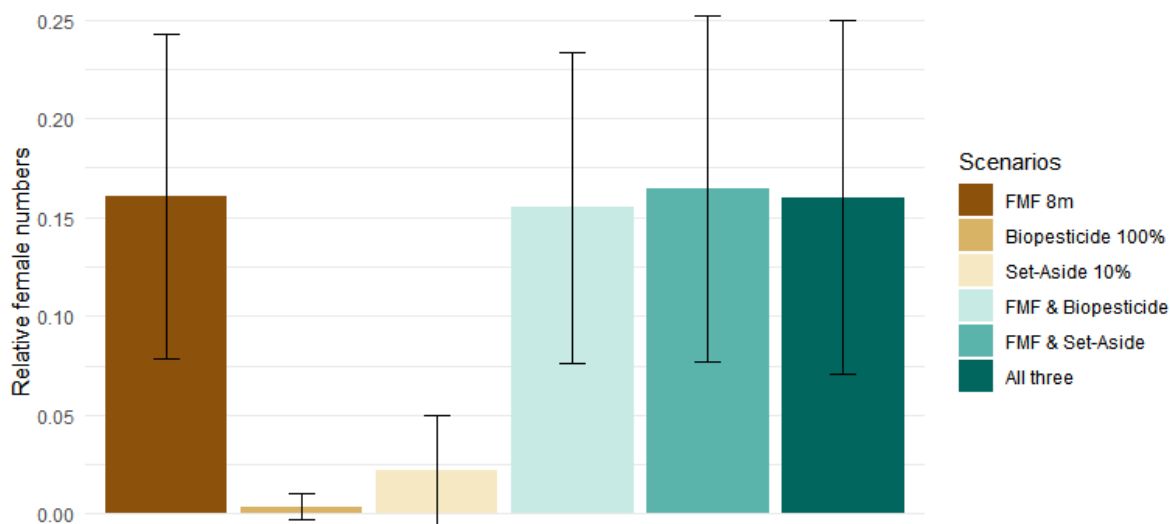
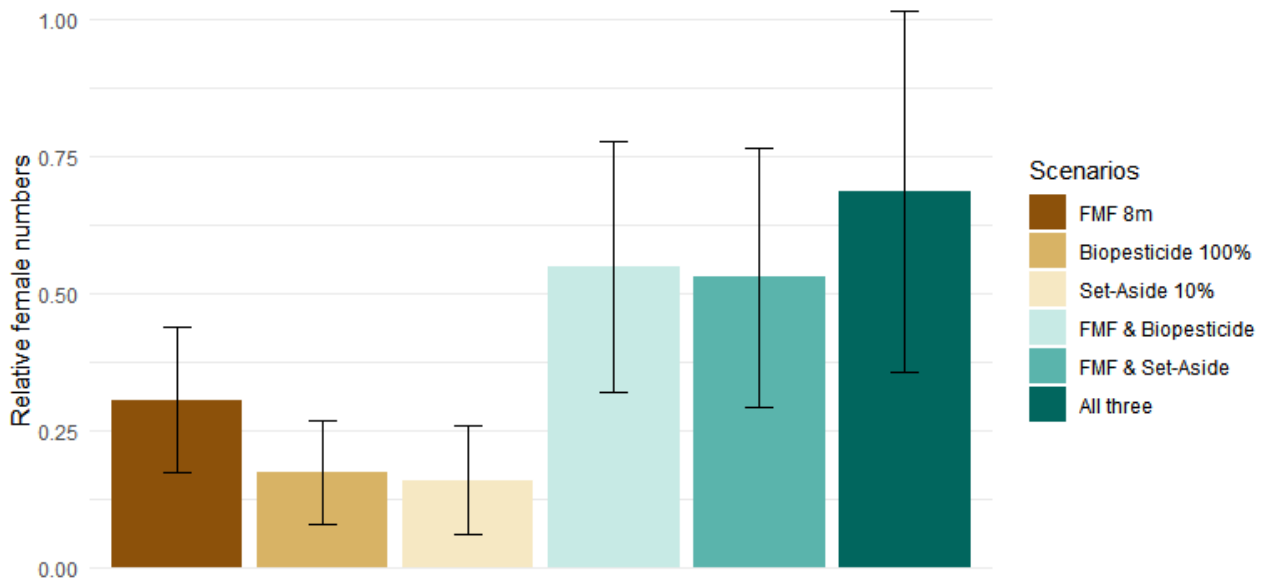


Figure 97 *O. bicornis* maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of female *O. bicornis* combining all countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

3.6.1.2 Predatory invertebrates

Maximum uptake scenarios had a greater positive impact than any of the component scenarios with an average increase in population size of 57% compared to baseline (Figure 98, Appendix 13, Table 13.3). There were differences between effects in different countries (Appendix 13, Fig. 13.9 & 13.10) but the combined effect across countries showed that biopesticide was slightly better than set-aside while including all three components outperformed using either combination of just two with a population increase of 68% vs. 55% (incl. biopesticide) and 53% (incl. set-aside) (Appendix 13, Table 13.3). Of the component scenarios flower strips were the biggest contributors to the population increase (Figure 98).



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Figure 98 *B. lampros* maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of adult *B. lampros* combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Spiders showed a positive response to maximum uptake scenarios, all of which outperformed component scenarios, increasing the average populations with 235% for *Euopaeus* and 553% for *Erigone* (Figure 99, Figure 100 & Appendix 13, Tables 13.5 & 13.7). The greatest effect was seen when using all three components (258% increase for *Euopaeus* and 641% increase for *Erigone*) with strong effects of flower strips. Set-aside had a greater positive effect than biopesticide when comparing two-component scenarios (Appendix 13, Table 13.5 & 13.7).

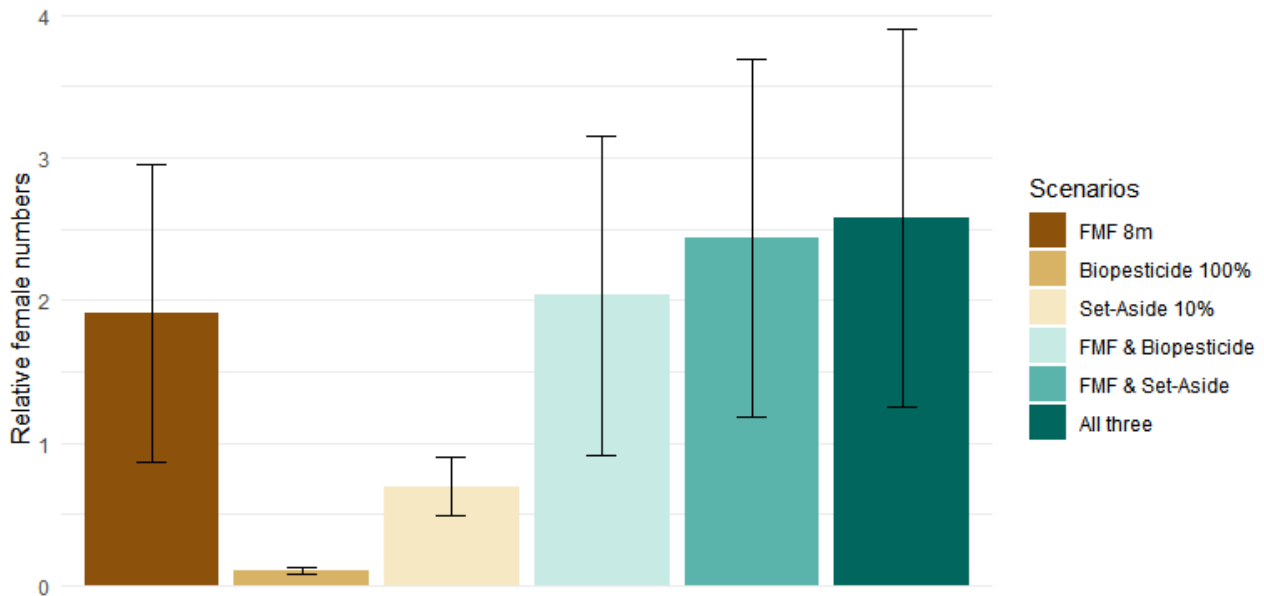


Figure 99 *Europaeus* maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of female *Europaeus* combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

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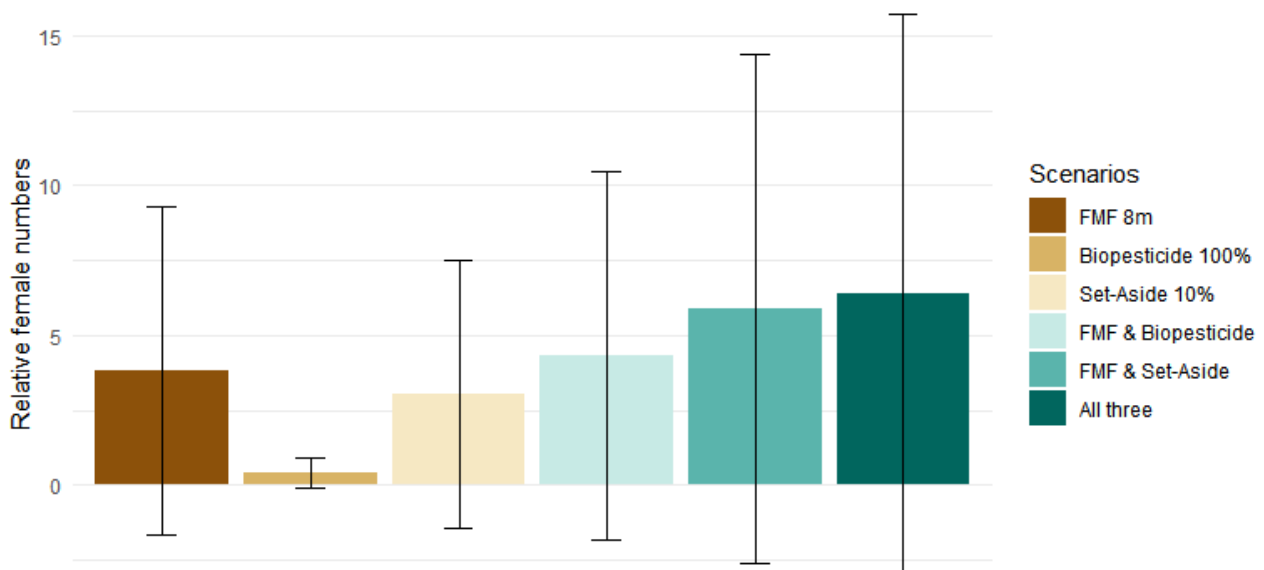


Figure 100 *Erigone* maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of female *Erigone* combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

3.6.1.3 Integrated pest management

Compared to baseline, aphids showed an average decrease of 23% for maximum uptake scenarios, with a combination of all three components having the greatest effect (-27%) (Figure 101, Appendix 13 Table 13.11). Comparing different combinations of maximum uptake component scenarios using set-aside was better at reducing aphid numbers than biopesticide, but two-component scenarios were generally less effective than using all three components (Figure 102).

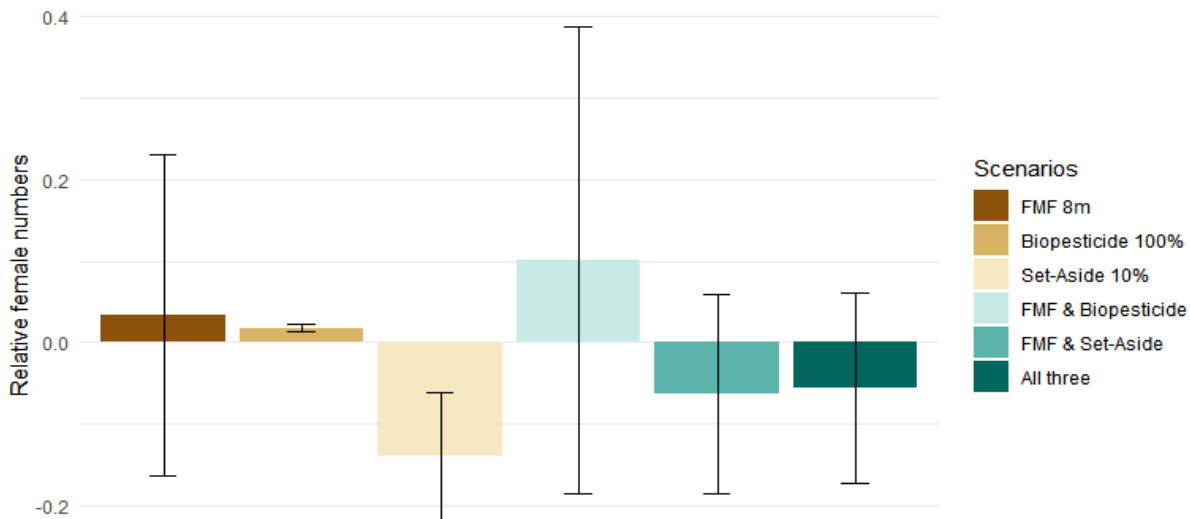


Figure 101 Ladybird maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of adult Ladybird combining countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

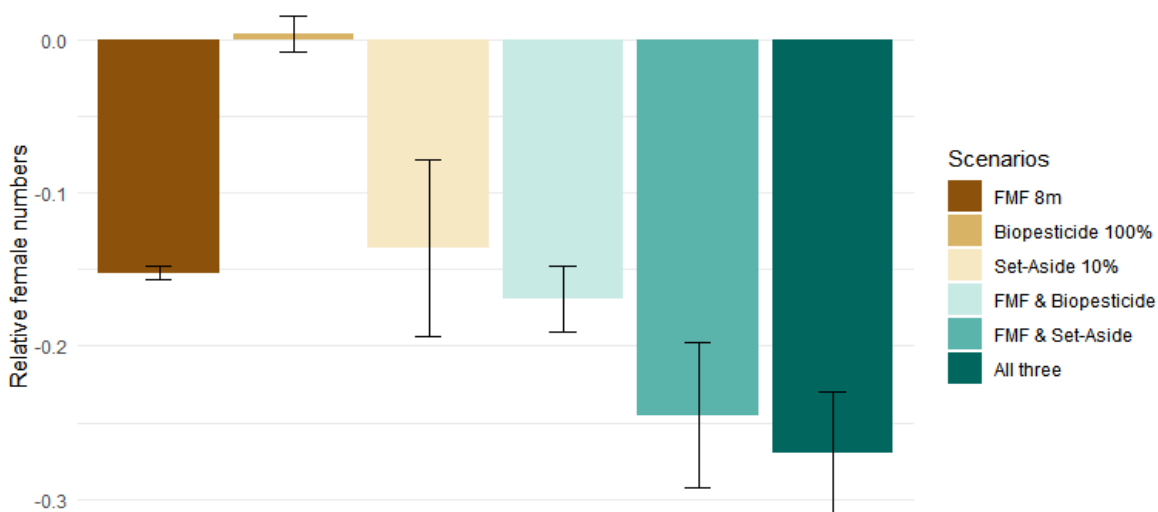
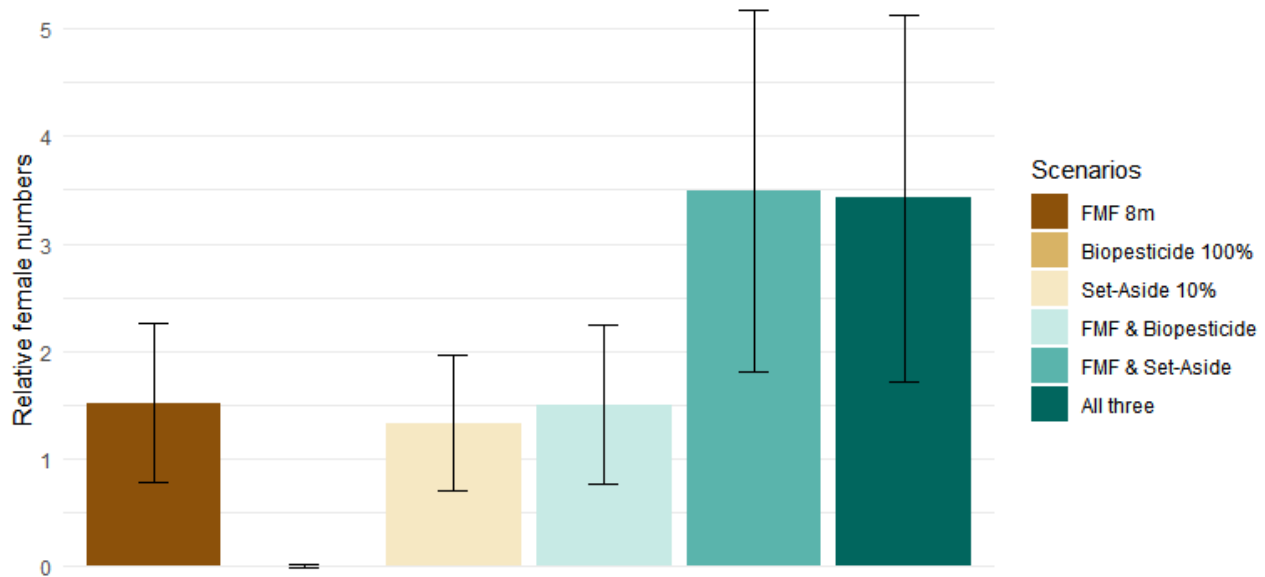


Figure 102 Aphids maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of Aphids combining countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

3.6.1.4 Vertebrates

For the maximum uptake scenarios biopesticide did not contribute notably to the increase in hare populations which seemed mainly driven by set-aside and flower strips (Figure 103). In fact, using flower strips in combination with biocide was less effective than using a pure set-aside strategy. However, the combination of flower strips and set-aside gave the best results with a 349% increase in population size relative to baseline (Appendix 13 Table 13.13) and was the best option for increasing hare populations of all stacked scenarios (Figure 103).



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Figure 103 Hare maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of female Hare combining all countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

For skylark there was no notable effect of biopesticides (Figure 104). Population increases in maximum uptake scenarios were thus driven by set-aside and flower strips which resulted in a population increase of 218% (Appendix 13, Table 13.15).

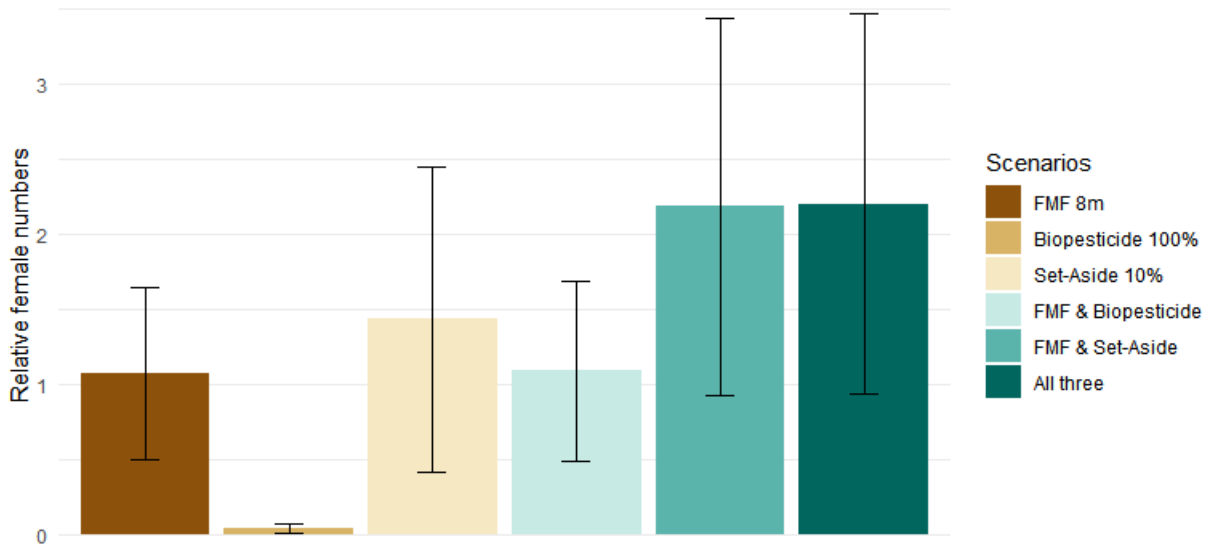


Figure 104 Skylark maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of female Skylark combining all countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

For vole the strongest driver was flower strips being equally good as a single component scenario as combining it with biopesticides, but with even better effects when combined with set-aside for the maximum uptake scenarios (Figure 105). Thus, there was no difference of including biopesticides as a third component (Appendix 13, Table 13.17). This makes sense as biopesticides do not have a direct effect on vole. A maximum uptake strategy of adding both flower strips and set-aside gave a 1005% increase in the population size (Appendix 13, Table 13.17).

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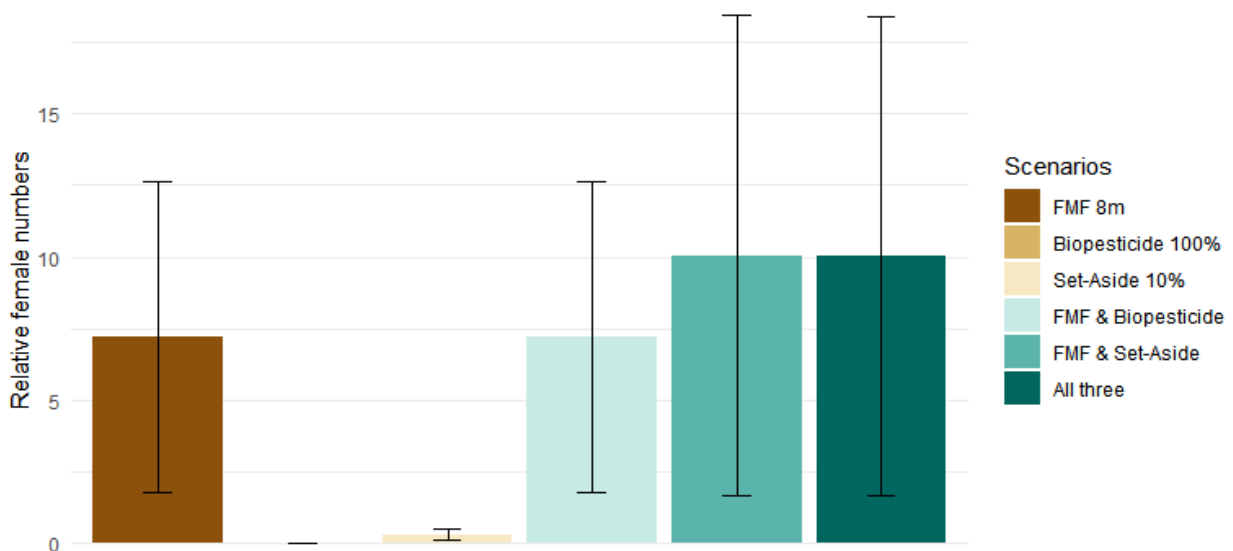


Figure 105 Vole maximum uptake stacking scenarios (greens) and component scenarios (browns) showing relative change in numbers of female Vole combining all countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

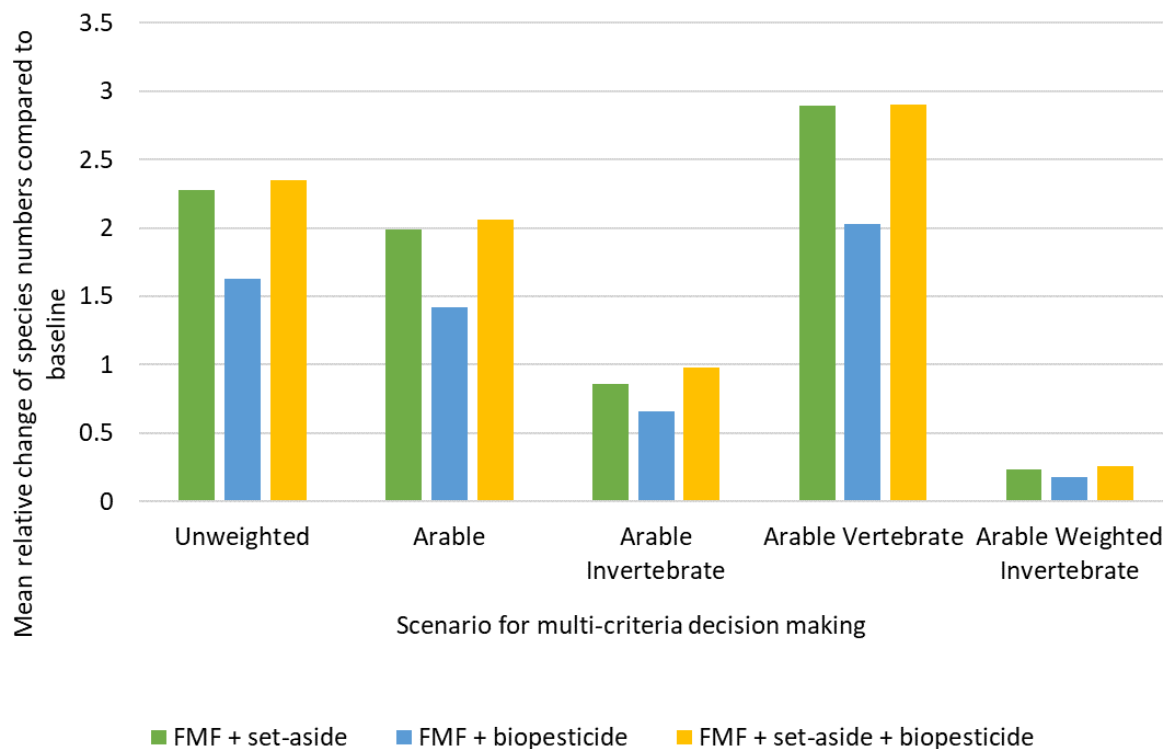
3.6.2 Effectiveness of the 'maximum-uptake' scenarios across species and landscapes

Table 16 summarizes the effectiveness of the 'maximum-uptake' stacking scenario across species. For *O. bicornis*, all stacking scenarios gave similar results, while for most of the species, the stacking scenario combining all mitigation scenarios performed significantly better than stacking scenarios combining only two out-of-tree mitigation scenarios. For *C. septempunctata*, aphids as well as *M. agrestis* and *A. arvensis* there was little effect of biopesticide 100% as scenarios including all three mitigation measures and including only flower field margins and 10% set-aside gave similar results. Only for *L. europaeus* was the effect of including all three measures less than including just two, namely flower field margins and set-aside. We also compared the effectiveness of the 'maximum uptake' stacking scenarios with the best performing single scenario, the 8 m wide flower field margins (Table 16). This comparison showed that the combination of 8m wide flower field margins with 100% biopesticides was not markedly different from applying flower field margins alone. The effectiveness of the stacking scenario was greater than the effectiveness of the flower field margins alone only when it included the 10% set-aside scenario.

Table 16 Relative change of maximum uptake stacking scenarios compared to baselines for each species; Red mason bee (*O. bicornis*), ground beetle (*B. lampros*), spider (*O. fuscus*), ladybird (*C. septempunctata*), aphids (*A. fabae*, *A. pisum*, *M. persicae* and *S. avenae*), Field vole (*M. agrestis*), European hare (*L. europaeus*) and Eurasian skylark (*A. arvensis*) and averaged across species excluding ladybird and multiplying the effect from aphids with -1. The overall performance compared to the best performing single management (FMF) is shown as a proportion. This is based on results from Germany and Denmark.

Species	Effectiveness of 'maximum-update' stacking scenario [%]			
	FMF 8m & 100% biopesticide	FMF 8m & 10% set-aside	FMF 8m & 10% set-aside & 100% biopesticides	
<i>O. bicornis</i>	10	11	10	129
<i>B. lampros</i>	44	41	53	
<i>O. fuscus</i>	139	172	182	
<i>E. Atra</i>	75	99	105	
<i>C. septempunctata</i>	10	-6	-6	
Aphids	-16	-26	-31	
<i>M. agrestis</i>	1102	1658	1656	
<i>L. europaeus</i>	107	304	294	
<i>A. arvensis</i>	104	245	247	
Average across species (without <i>C. septempunctata</i>)	200	319	322	
Performance relative to FMF 8m scenario (found in Appendix 13, Table 13.19)	1.03	1.64	1.66	

Across all weighting schemes, the greatest impact was achieved by combining all three mitigation scenarios, i.e., flower field margins of 8 m width, 10 % set-aside and 100% biopesticides, were combined (Figure 106). However, most of this effect (97% in the case of 'arable', 88% in the case of 'arable invertebrates' and 'arable weighted invertebrates', and 99.7% in the case of 'arable vertebrates' weighting scheme) was achieved when 8 m wide flower strips were combined only with 10% set-aside (i.e. when 100% biopesticides scenario was excluded from the stacking) (Figure 106). When 8 m wide field margins were combined with 100% biopesticides only (i.e. when 10% set-aside scenario was excluded from the stacking), the effectiveness of this stacking scenario decreased to 67-69% of the effectiveness of the stacking scenario with all mitigation measures combined (Figure 106).



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Figure 106 Comparison of the effectiveness of maximum uptake stacking scenarios according to different scenarios considered for the multi-criteria decision-making process.

4 DISCUSSION

4.1 Overview of work completed

In this report, we present the results of an extensive integrative simulation modelling task evaluating the range of agricultural management strategies across pedo-climatic zones in the EU for ESPs. To achieve this ambitious goal, the scope of the ALMaSS tool had to be significantly extended from the starting point at the beginning of the project. These extensions covered three main areas: 1) the addition of several new species models covering key ESPs not previously included in ALMaSS, and addition of a completely new model type; 2) extending the landscape component in terms of geographical coverage (to account for Europe's diverse pedoclimatic zones as well as socio-economic conditions); and 3) introducing new functionalities, including code developments for integration of new vegetation types and crop management, or integration of pollinator resource models, and a major overhaul of the codebase to improve operational speed. Some of these developments have been

facilitated by strong collaboration with other EU (e.g., B-GOOD, grant agreement no. 817622) and national projects (e.g., carried out for the PBL Netherlands Environmental Assessment Agency or German Environment Agency).

4.1.1 Species modelling

Thirteen species were selected for modelling, representing generalist and specialist pest control agents (two spiders *Erigone atra* and *Europaes fuscus* and two ground beetles *Bembidion lampros* and *Coccinella septempunctata*), a pollinator (*Osmia bicornis*), aphid pests (four different species, *Aphis fabae*, *Myzus persicae*, *Sitobion avenae* and *Acyrtosiphon pisum*) and important vertebrates of the agricultural landscape (*Alauda arvensis*, *Lepus europaeus* and *Microtus agrestis*). Among them, models for *O. fuscus*, *C. septempunctata* and four aphid species were developed from scratch, while the model for *O. bicornis*, although started in another project, was completed within the EcoStack project. Other species models have been incorporated into newly developed ALMaSS landscape models, including calibration to different climatic conditions.

Two important innovations distinguish our work from other population dynamics models. The first was developing a subpopulation approach for modelling species that, due to extremely large population sizes and lack of detailed behavioural data on individuals, are computationally too complex or impractical to model using a "traditional" agent-based approach. The subpopulation approach has been successfully applied to the modelling of aphids. Another major achievement was modelling a predator-prey system implemented for *C. septempunctata* and four common aphid pests. These models were run in parallel to observe and analyse the spatio-temporal interaction between predator and prey. This simulation represents the first time the integration of highly detailed predator and prey models has been successfully applied and integrated into a dynamic landscape model, allowing the impact of agricultural management on the predator-prey system to be tested at the landscape scale.

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Developing new models for so many species required an extensive, in-depth literature review on the biology and ecology of the species, consultation with specialists, and careful model design that required full collaboration between ecologists/biologists and the developers writing the code. During the process, new rules for documenting complex models were established to improve the transparency and functionality of the documentation process (Topping et al., 2022). According to these new rules, the first level of model documentation is the Formal Model, which is a peer-reviewed paper format that lays out the intentions for the model. The Formal Model includes peer-reviewed literature that identifies the components of the model, lays out the theoretical framework, modelling approaches and externalities, and plans for implementation. Preparing Formal Models for newly developed species models in ALMaSS has therefore been a considerable task, e.g. the published Formal Model for *O. bicornis* (Ziółkowska et al., 2023) was almost 50 pages long.

4.1.2 Landscape modelling

Extensive development of the ALMaSS landscape model has been carried out. Before the EcoStack project started, the fully functional ALMaSS model was only available for Denmark. This coverage was extended to Poland, Finland, Sweden, France, and Portugal during the project. In addition, through cooperation with other projects, the ALMaSS landscape models were made available for Germany (two federal states, Lower Saxony and Brandenburg) and the Netherlands. The greater coverage enabled the simulation of EcoStack scenarios in different pedoclimatic zones across the EU. The development of ALMaSS landscape models for new countries required collecting and integrating a huge amount of data with sufficiently high resolution and quality from different data sources and with different thematic scopes (topography, agriculture, agricultural management, vegetation, soil, weather conditions, etc.). Automatic and semi-automatic methods of data processing have been developed to allow automation so that any landscape in any of the analysed countries/regions can be

"captured" and used for simulation. This means that the set of landscapes selected for analysis can be easily expanded in future applications.

ALMaSS functionality was improved in many areas. The most extensive was the addition of new crop management models for the new countries and updating all the crop models for Denmark. This resulted in an increase in the number of vegetation types modelled in ALMaSS from almost 100 to the current count of 453. Although the landscape extensions were subject to a previous EcoStack report (deliverable D.8.1), the final work to test the impact on species, correct crop growth curves and management models, and mapping issues was done during the final simulation work reported here. This testing took considerable effort and resulted in the final version of the models used for the simulations.

Another part of ALMaSS landscape model that was added for EcoStack was the model of floral resources. This work was funded under Horizon 2020 project B-GOOD, and thanks to that collaboration, we could include the pollinator model (*O. bicornis*) in the current simulations.

4.1.3 Landscape selection

In all the countries and areas used in ALMaSS simulations we have the capability to select simulation landscapes from anywhere in the modelled area. This is further discussed below, but the decision taken was to find ten landscapes from each area that differed as much as possible in structure but having at least 55-60% coverage of arable land. These landscapes have been shared with the European Food Safety Authority as a basis for use in regulatory risk assessment of pesticides (EFSA et al., 2023) and to be used in other EFSA projects.

4.1.4 Scale of simulations carried out

The additions and developments applied to ALMaSS under EcoStack facilitated the first large-scale simulation-based analysis to combine detailed agent-based ESP models with dynamic simulations of landscapes across Europe. Thirteen species, 60 landscapes, and seven different EcoStack measures were combined. Thus, we developed a procedure for evaluation of agricultural measures and strategies, which is highly innovative and unique, but the downside of this was the requirement for huge computing power. However, even then, only a limited set of simulations could be performed, much less than initially hoped before the resource demands for this work were known.

4.2 Use of computing resources

Access to high-performance computing (HPC) was needed to run these simulations. This resource was not provided by EcoStack but was sourced through Danish and Aarhus University grants (see Acknowledgements).

These simulations required highly efficient high-performance and parallel-computing systems to cope with the fully integrated systems-based approach. In total, 9 million CPU hours were used on EcoStack simulations on two main HPC facilities. The available CPU resources effectively limited the number of combinations that could be run. Hence, full combinations of countries, species and scenarios were only run for DK, with most also for DE, and then fewer runs for the other countries. Using this strategy, we could identify the key scenarios needed to be simulated for the other countries for ecostacking.

Given that CPU hours were limiting, a rewrite of most of the species models was undertaken in 2023 to implement a threaded parallel processing capability. It was this efficiency improvement that made it possible to run the combined aphid species and ladybird scenarios even for the limited number of replicates and scenarios used. Each replicate required up to 40 hours even on the LUMI HPC, the third most powerful computer in Europe.

4.3 Local adaptation of species models

Some important changes and additions, especially regarding critical temperature-dependent processes, had to be made to the species models to adapt them to the different climatic conditions in the EU. For all existing models this was necessary as they were originally developed and tested using field and phenological data for Denmark. For the newly developed models, some adaptation mechanisms were included in the model design and the calibration process was based on data from different pedoclimatic zones as far as possible.

The original *B. lampros* model calculated temperature-dependent development for each developmental stage and winter mortality using air temperatures. This resulted in too high mortality and too short developmental stages, leading to severely reduced beetle populations when the model was tested for Polish climatic conditions (Ziółkowska et al., 2022). Therefore, the model was modified to include soil temperature at a depth of 3.5 cm instead of air temperature to assess the winter survival of beetles and the duration of developmental stages occurring in soil. The modification of parameters related to spring dispersal and reproduction triggers was also necessary to fit the original beetle model to the phenology data of the analysed countries. These adjustments allowed the *B. lampros* model to run successfully in all countries analysed except Finland, where populations died due to very high winter mortality, even when the model was driven by soil temperatures instead of air temperatures. The distribution of *B. lampros* in Europe reaches its northern limit in Finland, with the species being quite common in agricultural areas in the southern part of the country and becoming less common as we move further north. This may mean that Finnish populations have developed a local adaptation mechanism that is not well represented in our model. Therefore, to ensure the survival of *B. lampros* populations in Finland, winter mortality parameters were also adjusted.

Another example is the skylark model, which relies heavily on the insect biomass model, which is related to vegetation types and their growth, which is temperature dependent. The original skylark model was calibrated to an extensive data set from Denmark (Topping et al., 2013), and therefore it was not expected that the default parameters could be used to represent skylarks in other countries and time periods. To account for the different seasonality between continental and oceanic climates, the seasonality of insects and skylarks had to be adjusted for Poland and France. Here, both were shifted one month earlier. This realigned crop phenology and skylark and insect activity for these areas. No change was made for Germany and Finland. For Germany this is probably reasonable (for north-western areas), but for Finland the problem of a narrower breeding season was already part of the automatic adjustment in the skylark code. As the field data used to fit the original insect biomass model are already 22 years old, and current data suggest a general pattern of decline in insect diversity, abundance and biomass across European countries, a model recalibration was made to represent a decline in insect biomass available to skylarks. The adjustment, applied to all countries analysed, was based on Danish conditions (where a 46% decline in insect biomass has been reported since 2004 from the Danish Ornithological Association annual bird counts), thus assuming that the level of insect decline is comparable across European countries. Although recent studies based on systematic monitoring or national to global meta-analyses (see e.g. Hallmann et al., 2017, Hallmann et al., 2018, van Klink et al., 2020, Pilotto et al., 2020) suggest a rather complex pattern of insect decline that varies between regions and taxa, the specific country or regional data are either not readily available or provided for specific case studies, making them difficult to apply in the model. Incorporating adjustments to the insect biomass model with different levels of decline requires additional evaluation and testing in relation to skylark responses, similar to what was done by Ziolkowska and Topping (2019).

The model for *O. bicornis* already included some adaptation mechanisms related to the modelling of the duration of prepupal diapause, as the duration of this developmental stage seems to be the main mechanism by which populations of *Osmia* spp. from different geographical areas synchronise adult eclosion with local

temperature drops in autumn (Kemp and Bosch, 2005, Bosch et al., 2008). Nevertheless, the model was calibrated separately for each of the countries analysed in order to ensure the correct timing of the emergence from the nest in the spring and an appropriate population size. For the latter, the correct timing and duration of the pre-wintering period had to be ensured, as in the model the temperature conditions during the pre-wintering influence the overwintering mortality of the bees. In addition, the activity of the *Osmia* must be correctly synchronised with the flowering phenology of the main foraging plants in order to allow the populations to survive. The species is particularly sensitive to early flowering resources. Therefore, the flowering resource models had to be properly calibrated in all the EU countries analysed.

A final but important point is that in most species models we have used a simple degree-day model to calculate the development time of different life stages. However, a biophysical model (Sharpe and DeMichele, 1977) is much more likely to give the true picture. Unfortunately, there was insufficient data to parameterise this more complex model, as laboratory experiments conducted under constant temperature conditions often focus on optimal and suboptimal developmental temperatures and miss the more extreme ones. The use of a simple degree-day model may be one of the reasons for problems with models' calibration and performance, especially when species experience the lower temperatures (as in Finland, for example).

4.4 Effectiveness of the agricultural measures applied

4.4.1 Overview

The effects of different agricultural measures, both off-crop (grassy field margins and flower strips) and in-crop (crop diversification, rotational set-aside and legumes), as well as bio-inspired tools (biopesticides), on the populations of the analysed species were investigated across landscapes and countries. Field margins and set-aside were found to have the most positive effects across all species, followed by biopesticides (which had positive effects on all species, except voles and hares, on which they had no effect). This confirms the importance of semi-natural linear structures in agricultural landscapes as a measure to support multiple species (not only beneficial invertebrate predators and pollinators, but also farmland birds and small mammals) and to sustain important services, such as pollution control or nutrient cycling (Haddaway et al., 2018). Set-aside in the agricultural landscape can play a similar role to field margins, and for both measures, the type of management plays an important role (such as timing and severity of cutting). Our extensive simulations across different species and landscapes confirmed that the effectiveness of these measures in supporting biodiversity depends on the landscape context, being highest in homogenous landscapes of simple structure, but adding less in more complex landscapes, where the populations of beneficial species are already high and ecological processes are already on place (Tscharntke et al., 2011). They also showed that field margins were more effective than set-aside in supporting beneficial species in terms of relative population increases in relation to the area of land removed from agricultural use, i.e. for the same area of land intended for the application of an agricultural measure, higher relative population increases are achieved with the introduction of field margins than with set-aside. This may be related to the fact that field margins are better at supporting habitat connectivity and enhancing inter-population connectivity. In addition, as the type of set-aside introduced was rotational, this means that, depending on the species and cropping structure, crops suitable for breeding and/or foraging habitat may have been replaced by less suitable set-aside.

4.4.2 Field Margins, set-aside & legumes

The type and magnitude of the effects of increasing field margins varied between species and depended on the vegetation cover (grassy, flower or half grassy and half flower) and the management of the field margins, their width and overall abundance in the landscape. For the ground beetle *B. lampros* and the hare, grassy field

margins were preferred over flower strips, whereas for the red mason bee, the two spiders analysed (*O. fuscus* and *E. atra*), the vole and the skylark, flower strips had more positive effects.

Grassy field margins are known as being important overwintering habitats for *B. lampros* (Pywell et al., 2005, Knapp et al., 2022), but they also play an important role as source habitats for recolonisation of fields (Cole et al., 2012). Flower strips may have a similar role to grassy field margins for *B. lampros* if their management does not disturb overwintering beetles (as in our model, where flower strips were mown at the end of October). Set-aside was also beneficial for *B. lampros* populations but, as more unstable habitat, more strongly depends on immigration. For both dwarf spiders analysed, an increase in perennial habitats adjacent to crop fields, such as grassy field margins, flower strips and set-aside, is also beneficial, as such habitats have been shown to be preferred over arable fields, especially during periods when crops are inhospitable (Schmidt and Tschardt, 2005). Such habitats can attract potential prey, increasing the spiders' foraging efficiency (Kowalska et al., 2022). The positive effect of flower strips on spiders has also been linked to the complex vegetation structure and the specific microclimate they provide (Ditner et al., 2013). However, in the ALMaSS spider models, similar to the *B. lampros* model, the difference in preference between grassy field margins and flower strips could be associated with different timing of mowing activities, but also the direct interaction with prey availability depending on habitat type.

Flower strips can provide important foraging habitat for *O. bicornis* in agricultural landscapes, but only if they are composed of plants with flowering seasons that coincide with *O. bicornis* activity, i.e., from early spring to mid-summer (as it was designed in our simulations). Early-flowering wild plants are particularly important as they provide an important food source before mass-flowering crops such as oilseed rape, especially in agricultural landscapes without many woody patches of early-flowering trees. The composition of plants planted within flower strips is also important from a pollen quality perspective, as *O. bicornis* prefer some pollen sources over others (Filipiak, 2019). However, this aspect was not investigated in our simulations. The introduction of set-aside had a weak positive effect on *O. bicornis*, as the plants composing this habitat type flowered often later in the season, when the bee is no longer active. On the other hand, the introduction of grassy field margins was more common to negatively affect *O. bicornis* populations, which can be explained by a possible reduction in the area of flowering crops available to bees.

As field margins are important foraging habitats for skylarks, their increase in the landscape increases the food availability, but cannot alone compensate for the nest failure rates resulting from, for example, agricultural activities (Kuiper et al., 2015, Douglas et al., 2009). Flower strips were found to be a more effective measure for skylarks than grassy field margins, which may be related to the mowing regimes applied in these habitat types. In our simulations mown grass is cut at the beginning of May and the middle of September and flower strips cut between the end of August and end of October. Thus, flower strips are mowed later in the season compared to grassy field margins, thus providing more insect biomass for skylarks during the critical breeding season. Our results showing positive effects of set-aside on skylark populations confirm field studies (Donald et al., 2001). In addition to increasing food availability (especially during winter), set-aside may be beneficial for skylarks as an additional breeding habitat later in the breeding season (Bracken and Bolger, 2006). It has been suggested that the efficiency of these agricultural measures for skylarks depends on their spatial arrangement (in relation to the nest sites) in a landscape, which may partially explain the differences in population size increases observed across the landscapes considered.

Grassy field margins mown regularly during the growing season are also attractive for active hares, which prefer rather short vegetation (1-25 cm) and avoid higher vegetation and bare ground, especially in agricultural landscapes with comparatively large fields. On the other hand, flower strips are set-aside may be more beneficial for inactive hares as habitats providing year-round cover (Mayer et al., 2018, Petrovan et al., 2013).

Maintaining stable and well vegetated field margins can help limit vole numbers during population outbreaks, when they can otherwise reach high abundances and become agricultural pests (Planillo et al., 2023), although not the species simulated here. In our simulations, both flower strips and set-aside increased vole populations, while the effects of grassy field margins were mostly negative, which may again be related to the management applied (i.e. mowing regimes). In this case the grass acts almost like a trap crop, since at 8m voles will set up territories here, but be killed by the regular cutting.

Legumes only had significant positive effects for hares, but even here these were lower than the positive effects of set-aside. No impact of the pollen and nectar availability in legumes was noticed in the *Osmia* scenarios. This poor showing of the legumes may be due to the fact that they were included as conventional crops rather than as potential green manure crops. Hence harvested rather than being left as a resource for wildlife over winter as is sometimes the case.

4.4.3 Crop diversification

Crop diversification was selected for testing as an agricultural practice because of its potentially positive contribution to pest, disease and weed control, and its positive effects not only on crop production but also on associated biodiversity (Beillouin et al., 2021). However, our simulations showed diverse effects (both positive and negative) of crop diversification on the species analysed. Importantly, increasing crop diversification can be achieved in different ways, by introducing new crops into the baseline cropping system or by changing the proportion of existing crops in the baseline cropping system, either through temporal or spatial diversification (e.g., intercropping, mixed cropping, or companion cropping) (Hufnagel et al., 2020). In our simulations, only one of the possible implementations was tested, as crop diversification was achieved by removing the most represented crops in the baseline rotations and increasing the least represented crops to achieve a more even distribution of crop types represented in the landscape. As a result, the availability of some important crops for certain beneficial species (such as winter cereals for skylarks or winter oilseed rape for red mason bees) may be reduced in a landscape, leading to population declines, or the availability of host crops for pest species (aphids) may be increased in a landscape, leading to population increases (leading to further feedbacks in the predator-prey system of ladybirds and aphids). The pattern of such effects may vary between landscapes and countries, depending on farming systems and associated crop rotations. Unfortunately, due to time and computational constraints, testing of this measure was limited to Denmark and Germany, and other implementations of crop diversification were not tested in this study. In our simulations we also considered the effects of increased legume cultivation. Again, a variability of responses was found, with negative responses likely associated with a decrease in the availability of beneficial habitats for the species studied (similar to the crop diversification measure).

4.4.4 Biopesticides

It was assumed that biopesticides are equally as effective as chemical plant protection products (PPPs) for targeted organisms if applied twice and that they have little to no adverse effects on beneficial organisms. In this scenario, the effects of biopesticides on pest species have the same level of control. Therefore, all biopesticides have the same effects on the four aphid species as the normal pesticide. However, all biopesticide effects on non-targeted animals (skylarks, hares, beetles, spiders, and solitary bees) are reduced. Biopesticides were thus constructed to reduce the lethal impact on NTAs by 100%, 95%, 90%, and 80%, where 100% is equivalent to no lethality. If $X\%$ denotes the chemical impact on the pest, and mortality for NTAs is given by $Y\%$ of the current chemical impacts (where a value of 100 in both cases means that they are equivalent to using the current chemical approaches, while 0 means no mortality), the $X;Y$ pair for the biopesticide scenarios will be (100;0), (100;5), (100;10), (100;20).

Insects are the main food source for skylark and spiders (*E. atra* and *O. fuscus*). We assume the insects for skylark are mainly from the NTAs. Thus, all the biopesticides will increase the insects for skylark, with the most significant increase at 100% and the least at 80% compared to the normal pesticide. But for the two spiders, their food source can come from both NTAs and the targeted pests. Here we assumed that the spiders' food was affected at the same rate as the pest. In both cases the true conditions are somewhere between, but with skylarks eat larger food than the spiders the tendency should be reflected in the choices made here. However, in the case that a biocide only affected e.g. aphids, and no other major prey, which in this case in Collembola, then this assumption would need to be altered.

4.4.5 Integrated pest management

The scenarios evaluated here show a huge potential for use of this tool in integrated pest management (IPM). This can be done on various levels of complexity. One option is to use the multi-criteria decision-making to focus on positive effects on natural enemies and negative effects on pests. This option is computationally lighter because it involves running species separately and assessing responses as a group. However, this approach misses potential interactions. As the prototype of a more integrated approach, we have developed the ladybird and aphid simulations. Although this is a single species of beneficial, it shows what is possible when fully integrated modelling of landscapes and multiple species is implemented. Ladybirds track the aphid population in space and time but are delayed in their responses and affected by local densities, meaning there is a weak correlation between ladybirds and aphids at the landscape scale, but a tight one at local scales.

Inclusion of further species of natural enemies can be done in two ways. If enough computing power is available, the beetle and spider models can be dynamically linked in the same way as the ladybird and aphid. Thus, generalist density would feed to local mortality for aphid populations. This would be the most realistic approach. However, because we can make the assumption that the generalists are not affected by aphid numbers, but the reverse is true, we have another alternative. It would be possible to run the generalists separately, generate a density map through time, then run same scenario for the aphids and ladybirds using the generated density map to determine background aphid mortality levels. This needs in total as much computing power but means it is possible to run the component simulations on a smaller facility.

Seen from the results on populations of *Bembidion lampros*, *Europaeus fuscus* and *Erigone atra*, many of the managements used can benefit generalists. These could reduce the speed in which aphid populations increase, allowing specialist predators to exert greater control. This suggests there could be a considerable advantage in linking the models together, allowing both wildlife and IPM benefits to be evaluated simultaneously.

Although realistic and expected, ladybirds due to their dependence on the aphids as the major food source, followed their pattern for the scenario impacts. The reduction in mortality when using biopesticides did not appear to have much impact on the ladybird population. This is because although more of them survived the pesticide application the majority of life stages would starve due to the aphids being killed.

The positive impact of the populations of *Bembidion lampros*, *Europaeus fuscus* and *Erigone atra* would be beneficial from a pest control perspective. Although they were not linked in the simulation, the generalist predators alone won't control pest population, they contribute towards slowing down aphid population growth.

The main scientific issue with this approach is to determine the extent to which the species assemblage we use is representative. We currently have only one specialist predator but should include at least a parasitoid because their dynamics is different to the predators. We also have only four aphids, which gives good coverage, but non-pest aphids are not represented and also form a resource for the natural enemies. We have attempted to represent this by providing better ladybird conditions in off-crop areas, but this complex needs much more detailed work specifically on these aspects.

Although the four modelled aphid species colonise a large range of different crops, they don't reflect the entire range of crops simulated, which could mean more food for specialists than predicted. It also means that some of the relative negative impacts shown by scenarios such as 8m field margins and 10% set-aside don't necessarily mean a reduction in aphid outbreak risk or outbreak size, but simply reflect the reduction in available aphid host crops in the model.

The technical issues are primarily the scale of HPC resource needed. We improved efficiency remarkably by using threaded execution, but greater efficiency could be gained. One avenue available to reduce simulation resource use is developing the sub-population code for GPU. This will likely provide substantial benefits over CPU processing but requires specialist development and was well beyond the scope of EcoStack.

4.4.6 Maximum Uptake stacking scenarios

Table 17: The relative impact summed over three management scenarios (A) the maximum stacking scenario where all three managements are combined compared to the baseline (B), the absolute difference between sum and stack impacts (C), the difference as a percentage of the summed impacts (D). Mean calculated without ladybirds and inverting aphid impacts. Results are based on combined DK + DE scenarios since these were the only ones where all individual scenarios were run.

Species	FMF + Biopesticide + Set- Aside (A)	Maximum Stack Scenario (B)	Absolute Difference B-A (C)	Proportional Difference C/A (D)	Maximum Stack Scenario (all countries) (E)
<i>O. bicornis</i>	12%	10%	-2%	-17%	16%
<i>B. lampros</i>	48%	53%	5%	10%	49%
<i>O. fuscus</i>	199%	182%	-17%	-9%	204%
<i>E. atra</i>	123%	105%	-18%	-15%	410%
<i>C. septempunctata</i>	-9%	-6%	3%	-33%	-13%
<i>A. fabae</i> , <i>A. Pisum</i> , <i>M. persicae</i> and <i>S. avenae</i>	-29%	-31%	-2%	7%	-27%
<i>M. agrestis</i>	1150%	1656%	506%	44%	1005%
<i>L. europaeus</i>	232%	294%	62%	27%	342%
<i>A. arvensis</i>	279%	247%	-32%	-11%	220%
Mean	259%	322%	63%	24%	16%

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From the multi-criteria decision-making analysis, it is clear that the field margin managements have the largest per unit area impact. The impacts vary considerably with species but taken as a whole it is possible to gain major impacts on vertebrates with the margin scenarios alone. Thus, if it is possible conversion of arable area to flower strips will be the first priority. However, it is also important to clearly define the goal of the assessment since vague goals to increase biodiversity will not provide sufficient information to design managements. Despite the complexity of ALMaSS models, the simulation results provided are easy to interpret when compiled in a table of relative effect (see Table 17). Landscape simulations, such as ALMaSS, can be an important tool in

multicriteria decision-making by simulating a wide range of managements and contexts and provide supporting information for filtering management options based on specific conservation goals. An important aspect here is not only that effects differ between species, but also landscapes and countries. Thus, a more detailed multicriteria analysis could be performed for countries and regions. The winning stacked management might then be different when local context is taken into account (Topping et al., 2019).

We provide here a method for determining which scenarios should be combined in stacked scenarios and presented this method for a set of weighting schemes. These results show that the selection of weighting scheme should depend on the management goal but should also take into account costs associated with the application of a given measure. For example, if a primary goal is to support pollination service, then the results for *O. bicornis* should have a stronger weighting in the decision than a more charismatic species such as skylark. The weight of the skylark could then be made less than 1 with lower values leading to a reduction of the influence of skylark, down to zero, where skylark would not be included at all in the decision. Additionally, if the primary goal of farmers is to produce as much as possible and maximise revenue, and therefore, if an 8m field margin for example cost four times as much land as 4m, but does not at least double the impact 4m, then a 4m field margin may give the bigger cost benefit. We, therefore, assessed the scenarios with different ways of weighting species, towards different goals, and included simple costs, using arable area lost. But our cost benefit analysis only includes examples of objectives and costs and could include different species or combinations of species and with greater knowledge additional costs. The analysis could also have weighted countries differently based on confidence, or importance of a particular goal in a country.

In our decision-making examples we did not include other benefits for agricultural ecosystems, not related directly with the ESP / biodiversity, such as impacts on soil conservation or water pollution, environmental pollution with pesticides. These could be added to future assessments. In addition, a factor that might be important is that the impact of an ecosystem service is also dependent on the size of the ESP population. Weighting of the multi-criteria decision-making metric could thus include the starting population size.

Overall, if the best-single measure can only be selected, that would be 8m flower strips (incomparable gain in comparison with set-aside and biopesticides). The effectiveness increased considerably where this measure was combined with set-aside measure. Biopesticides did not make a difference, however, this does not include any other benefit of pesticide reduction which could be used to add a scaling factor to this table, thus increasing the contribution of the biocides. However, the effectiveness of stacked scenarios depended on species, with vertebrates being much more positively affected than invertebrates. A clear and interesting effect is that combining the scenarios in a single scenario (B in Table 17) had very different impacts for different species, with vole, hare and *Bembidion* benefitting from a synergistic effect, whereas, although positive and large effects were observed for both spiders and the skylark, the sum of the individual management scenarios were greater than the combined stack. This effect is not a simple one and depends on the balance between the density dependent factors at work, effect of habitat extensions and or landscape permeability effects and the consequence of what is taken away to be replaced with the new habitats. However, as is clear from column E in Table 17, this effect could be different in other countries. When assessing across all six counties the effects were generally similar, but especially in the case of Erigone and vole, the impacts could be quite different in magnitude.

4.5 Variation in responses

It is very clear that context is extremely important when considering baselines and evaluating responses. We have differences between baseline population between landscapes within countries, differences in the direction of the responses amongst species and landscapes and countries. This is further complicated by differences in the species responses to managements which can even be in opposite directions. This

phenomenon has been reported before, also for ALMaSS simulations. For example, the impact of pesticide application was heavily dependent on landscape in hare simulations (Topping et al., 2016). However, this is the first time that this trend has been documented across all species and landscapes, showing that this is the rule not the exception. Even in closely related species, such as the two spiders, differences can be significant, for example in some scenarios responses in DE & DK are simulation for *Erigone* and *Europaeus*, but PL is different, in others PL is the same and DK & DE different. Although always possible to be wise with hindsight, and with the benefit of data analysis, it is extremely difficult to predict these effects in advance. (Topping et al., 2016). However, this is the first time that this trend has been documented across all species and landscapes, showing that this is the rule not the exception. Even in closely related species, such as the two spiders, differences can be significant, for example in some scenarios responses in DE & DK are simulation for *Erigone* and *Europaeus*, but PL is different, in others PL is the same and DK & DE different. Although always possible to be wise with hindsight, and with the benefit of data analysis, it is extremely difficult to predict these effects in advance.

One aspect of the results we did not cover is the question of whether to rely on relative or absolute values when evaluating impacts. Here we only analyse relative values. This is because typically this is the preferred method since it controls for local variation in population size due to context. However, there is an open question when dealing with ecosystem services, since then at least if the service is limited, absolute numbers matter. If we consider a population of 100 beetles in a field and increase it by 10%, we have 10 more beetles, but if we started with 100 thousand, we have a difference of 10 thousand. One is likely to have a huge impact on the service, the other not. This is a further consideration in the choice of criteria for multi-criteria decision making and evaluation of the IPM potential and underlines the need for clear management goals before embarking on simulation analysis.

4.6 Open questions and future work

There were many questions which we could have asked, and many were mistakes made in learning how to set up such a comprehensive analysis. One important issue is that moving between countries is not easy. There are difficulties in standardisation in both landscape and species simulation activities. In terms of landscapes, mapping issues were the first challenge, since different countries record different data and even when the same data is recorded this can be done or saved differently. Standardising landscape classifications between countries and assuming that these have the same behaviour in each is very difficult except on a very general level. Vegetation growth models were another challenge. The current system uses Danish models and applies these to all countries, but this is a stretch, and does not take into account local adaptation e.g. cold tolerant cultivars. Another problem with the growth models is that they are driven mostly by day-degrees, which works well in spring and summer but often fails to generate realistic patterns in autumn and winter because the absence of warm degrees does not have the same effect as the inclusion of 'cold' degrees in the model or light regime.

When comparing across countries there is also a large difference between the detail that was available for the farm management. Denmark has by far the most detailed and well-developed farm models, with good models available for DE, PL and FI. NL and especially FR have much less detailed farm models due to the level of detail of available in EcoStack. In the case of Sweden this data was so thin that Sweden could not be used in the analysis. If we really want to make between country assessments, then the level of farming management simulation should be much more comparable.

From the species perspective the problems are similar to landscape simulation. These complex models are often only tested and parameterised for one country since data may not be available. This is normally the case for validation data, which results in a calibration for a particular case. This case may not represent the situation across Europe. For example, *Osmia* was calibrated largely on Polish and German data, but we know that

populations are locally adapted to temperature regimes in warmer areas, however, we do not have the data to generate calibrations for these areas.

The fact that we did achieve the coverage we have was in part due to the collaboration with H2020 PoshBee, and B-GOOD providing ecological information and pollen and nectar modelling.

These drawbacks associated with species and landscapes notwithstanding, the potential for use of model tools developed here go far beyond what is reported in this report. Huge numbers of landscapes can be created from the data collected, and very many scenarios could be designed and analysed. By changing the selection of landscapes questions related to the response of species and or management impacts as a function of landscape heterogeneity could be addressed. Through the addition of further species new questions could be addressed. For example, evaluation of conservation management would be greatly enhanced by inclusion of hedgerow species such as e.g. bush nesting birds such as whitethroats and edge specialists such as ringlet butterflies.

Next steps would ideally be to consolidate the work done here by addressing the shortcomings of the landscape modelling in different countries to bring all countries to a comparable level. The range of species used, and the number of species integrated for e.g. IPM, should also be addressed. However, as it stands the model systems and approaches developed are useful in their own right and form an excellent basis for policy and strategic analysis in the future.

5 CONCLUSIONS

This report covers a wide range of topics, species, and landscapes. As a consequence, no one aspect is analysed in detail, rather we provide the basis for a tool set that can be used and developed further to assess complex interactions between landscapes, climate, species and management. Our analysis is unique due to our dynamic simulation with dynamic landscapes. We have achieved multi-country, multi-landscape, and multi-species interactions, including dynamic simulation at high resolution of aphids and ladybirds using a novel population modelling process. As such the main outcomes are the provision of the tools, workflows, and models. The results, however, do indicate some key points that should be considered when evaluating management impacts or management strategies in the future.

The main conclusion pervading all results is that local context is critical in determining the responses of animals. This may seem obvious but in fact in most model systems local context is completely ignored, since most models are generated to look at general effects and larger scales. Given this context dependency it seems clear that the validity of these models for strategic evaluations needs to be considered carefully. This result also means that there is no single easy solution to management goals that require manipulation of populations of species. Although here we show that the best option to maximise effects is the use of flower strips, not all species respond positively, and this conclusion is based on the weightings we use, and the species used for evaluation. Given that there is no 'silver bullet', the objectives of the analysis must be very clear before starting. If the management objective is to promote skylarks, then a very different management would be needed than if promoting in-field predator populations. Thus, narrowly and clearly defined goals are necessary.

Based on the goals the species set used can be determined and justified. Again, using the 'wrong' species will result in unnecessary noise and confusion in the analysis. Criteria for landscape inclusion needs to be similarly considered and described clearly. Here we focussed on typical intensive arable landscapes, and asked the question what management or combination of managements would lead to the best overall impact on ecosystem service providers. The result was clearly that flower strips gave the best result, followed by grass strips and set-aside. The key point about the flower strips was that this was the best way to support the pollinator populations, hence their better performance overall. Combined management scenarios give better all-round results, but on a cost-benefit basis the best return per unit area used is by focussing on flower strips.



These results are however based on the assumption that all farmers do all managements, which is unrealistic. However, this is addressed by another report from Work Package 9.

Future development of the tools here should focus on the consolidation of landscape simulation models and species already existing. Following that expansion of the species model pool to include species characteristic of other habitats would be desirable.

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Below we show the results for all species; red mason bee (*O. bicornis*, hereafter referred to as Osmia) a ground beetle (*B. lampros*, hereafter referred to as Bembidion), two spiders (*O. fuscus* and *E. atra*, referred to as Oedothorax and Erigone, respectively), ladybird (*C. septempunctata*, referred to as Ladybird), aphids (four species; *A. fabae*, *A. pisum*, *M. persicae* and *S. avenae*, referred to as Aphids), European hare (*L. europaeus*, referred to as Hare), field vole (*M. agrestis*, referred to as Vole), and Eurasian skylark (*A. arvensis*, referred to as Skylark). We show the baselines across countries (Germany (DE), Denmark (DK), Finland (FI), France (FR), the Netherlands (NL), and Poland (PL)), and then go into detail for each country and landscape. We show the absolute number of individuals, and the scenarios relative to the baseline. We also show relative abundance and occupancy which are helpful in explaining changes in population. Where we have shown relative values in a table, the confidence intervals may appear the same as the mean value. This is due to non-symmetrical confidence intervals and rounding. The values are different.

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1 FINNISH BEMBIDION WINTER MORTALITY

Bembidion lampros was, like several of the species, originally calibrated in Denmark. When running scenarios in Finland the population was not viable, and Therefore the temperature threshold for increased winter mortality in Bembidion was adjusted. Below, **Error! Reference source not found.** presents the results of simulating Bembidion in Danish landscapes, but with weather from each of the applied countries. In addition, the alteration of the temperature threshold is presented (5 values). Finland is approximately 10 degrees Celsius colder in winter, which corresponds to adjusted threshold value finally selected.

Bembidion in Danish landscape with weather from other countries

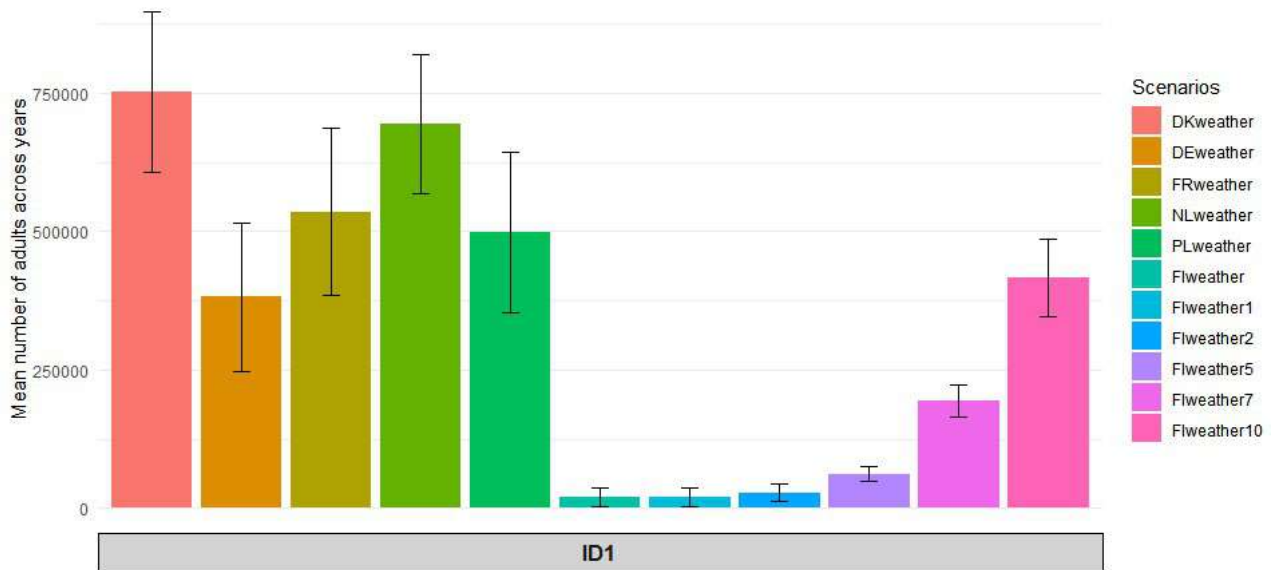


Figure 1.1 A 10-year simulation of Bembidion model in a Danish landscape with weather input from each of the applied countries, where Finnish weather (Flweather) results in a markedly smaller population compared to other countries. A longer simulation of 30 years showed that Bembidion populations could not survive in Flweather. Therefore, the winter mortality threshold was scaled down from counting below 0°C to below -1 (Flweather1), -2 (Flweather2), -5 (Flweather5), -7 (Flweather7) and -10°C (Flweather10).

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2 OSMIA

2.1 Baselines

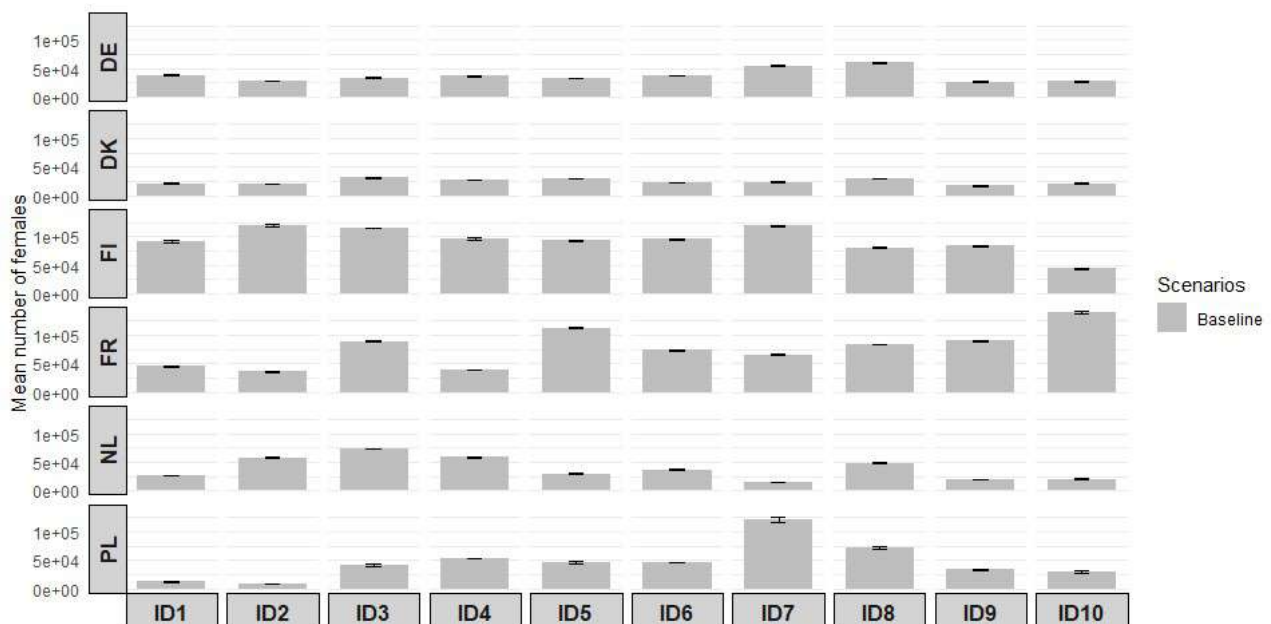


Figure 2.1 *Osmia* baselines for each country and landscape.

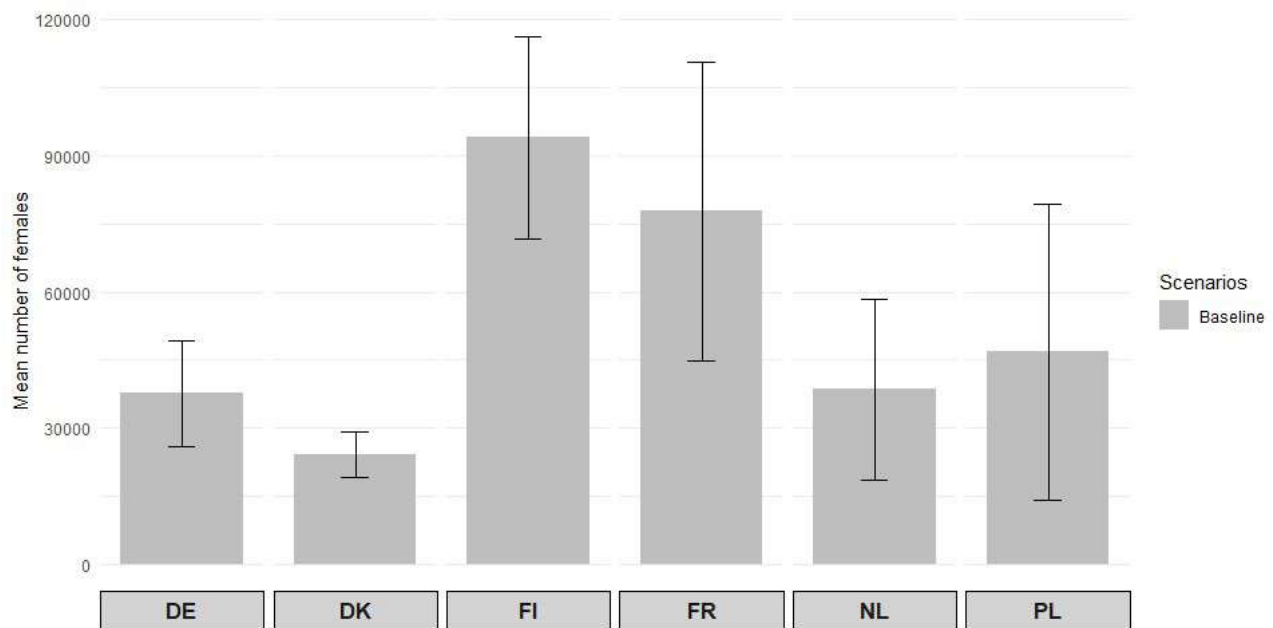


Figure 2.2 *Osmia* baselines for each country combined across landscapes.

2.2 Germany

2.2.1 Crop diversification

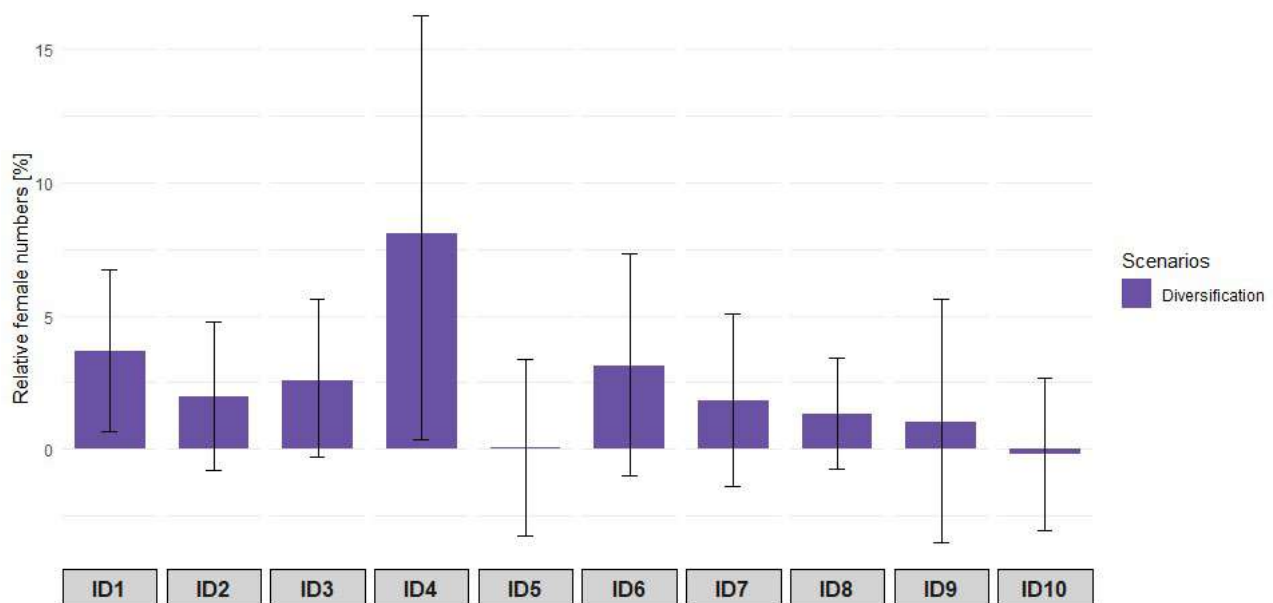


Figure 2.3 Diversification scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

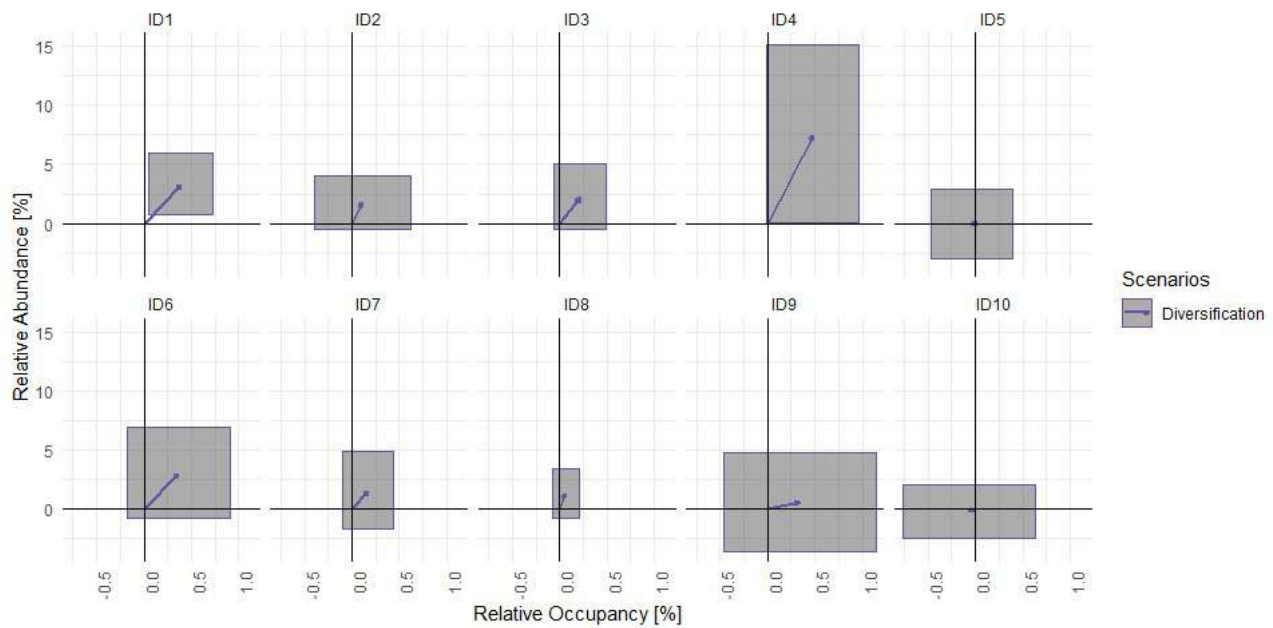


Figure 2.4 Diversification scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.2 Flower field margins

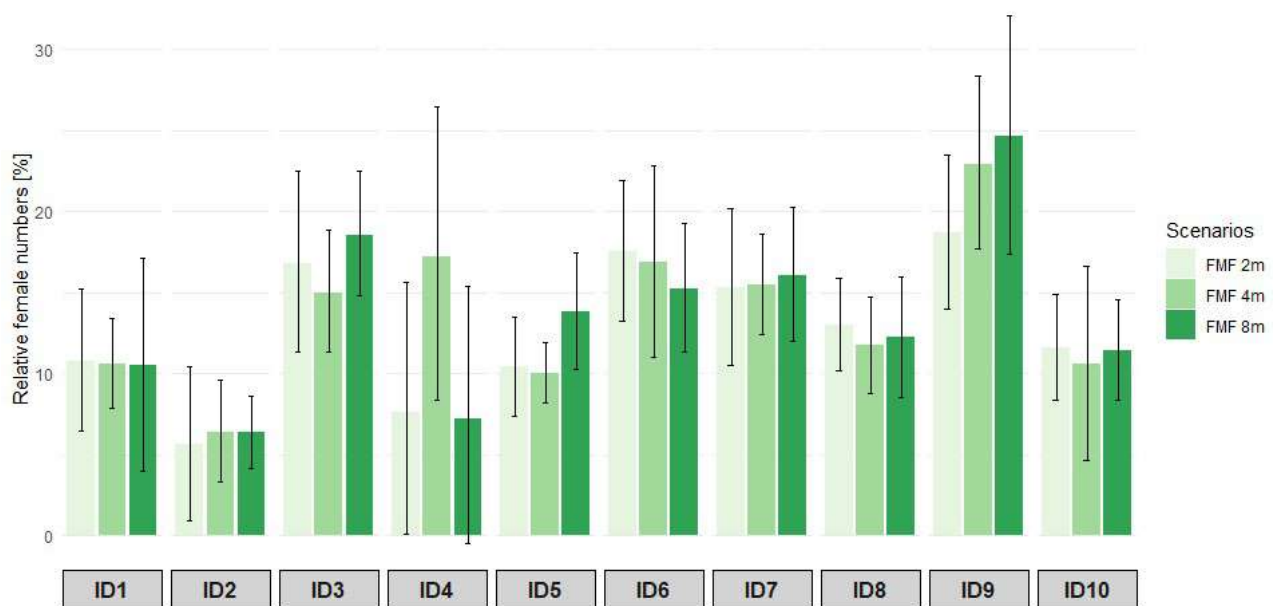


Figure 2.5 Flower field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

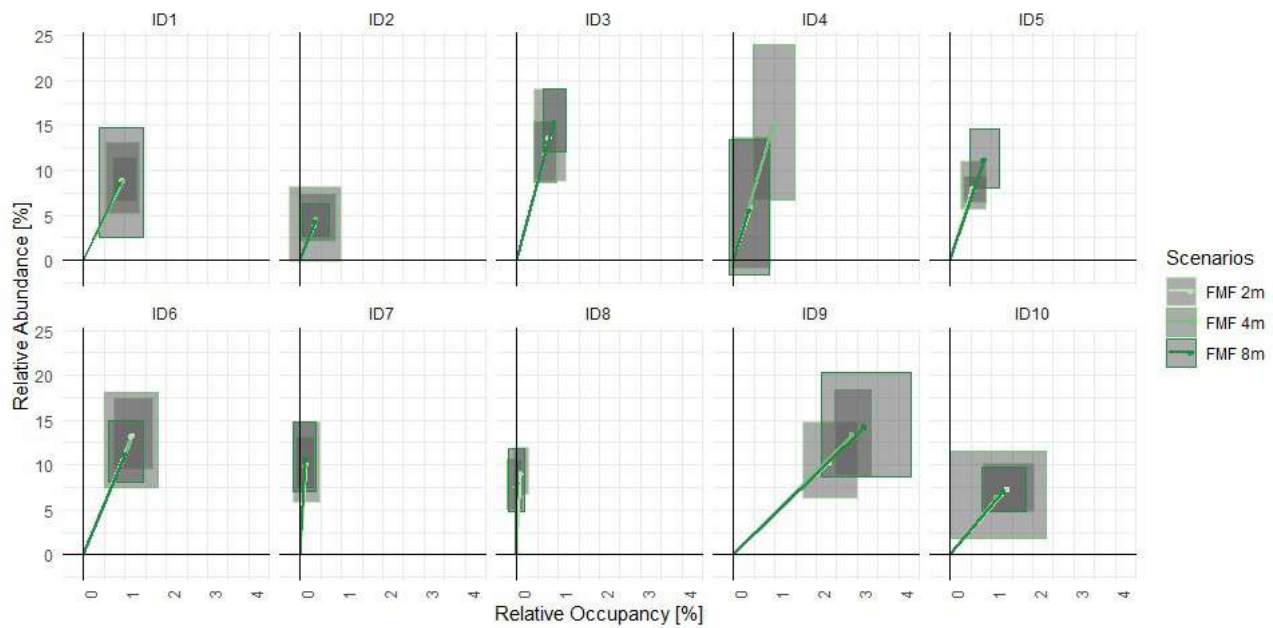


Figure 2.6 Flower field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.3 Grassy field margins

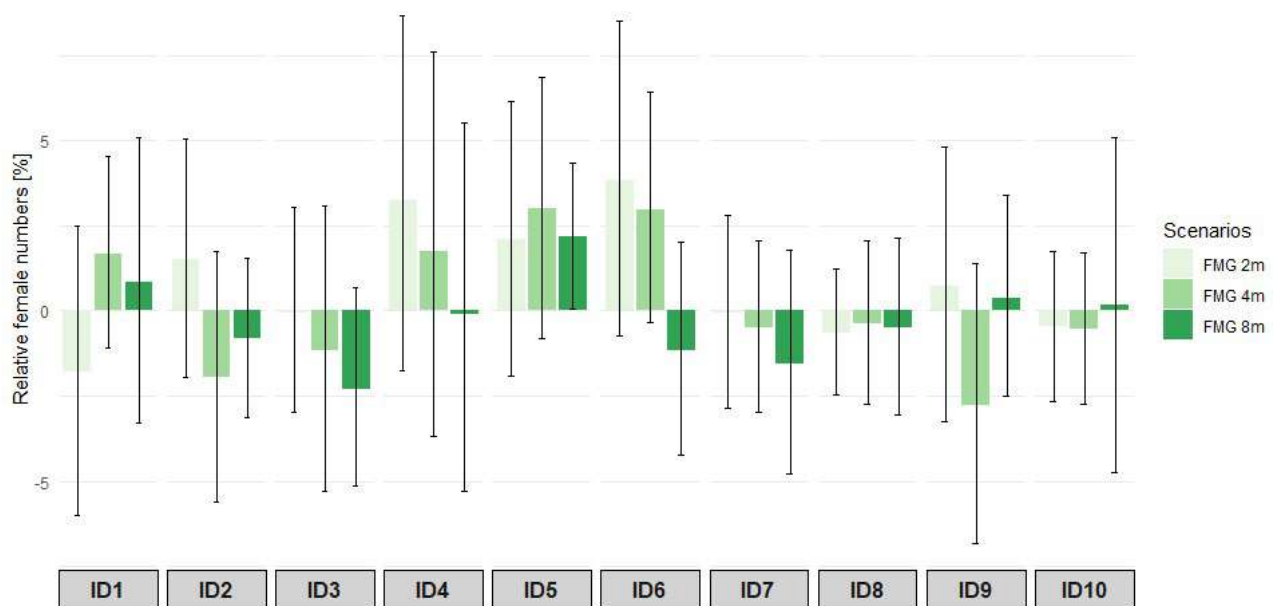


Figure 2.7 Grassy field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

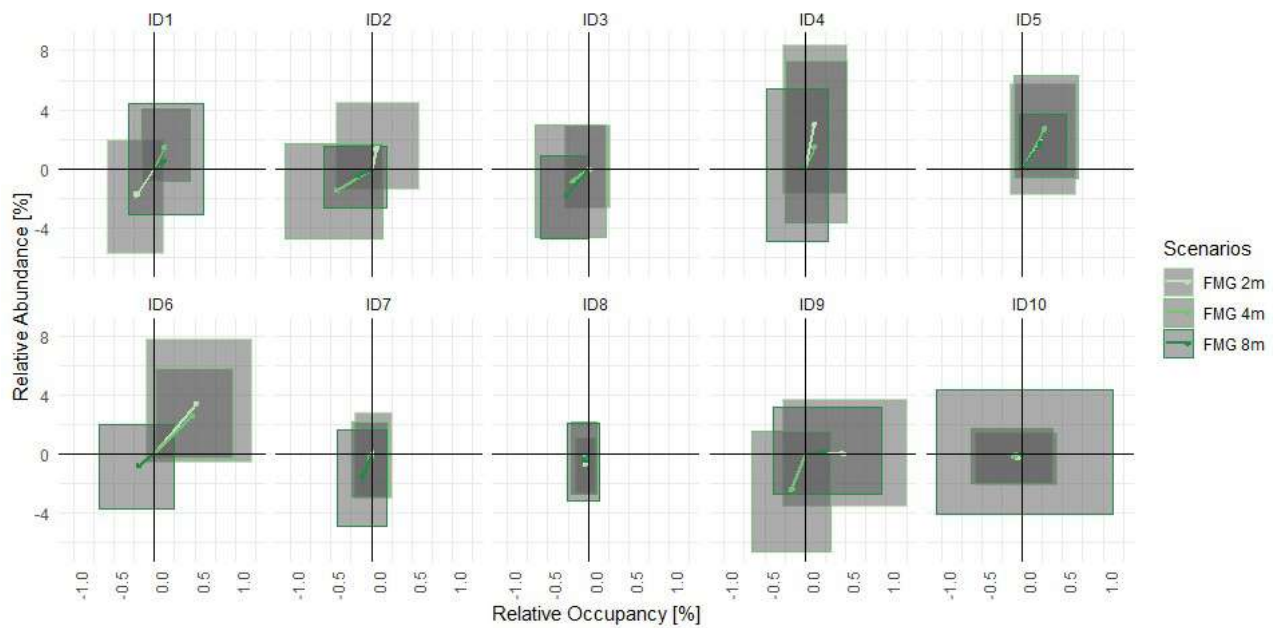


Figure 2.8 Grassy field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.4 Mixed field margins

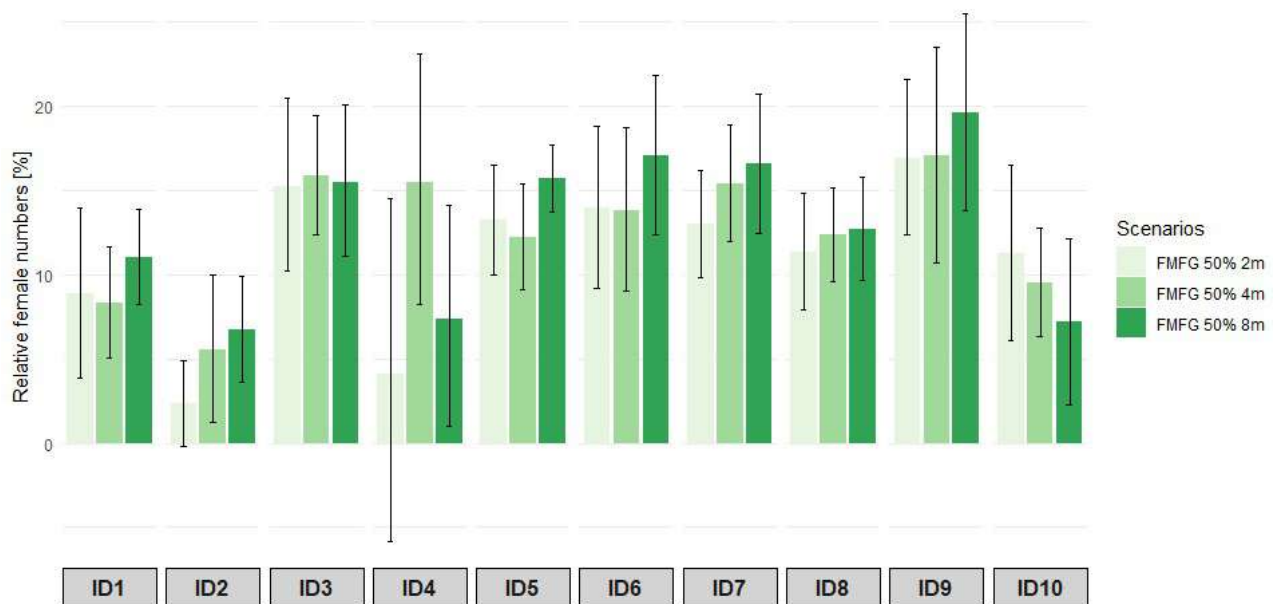


Figure 2.9 Mixed field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

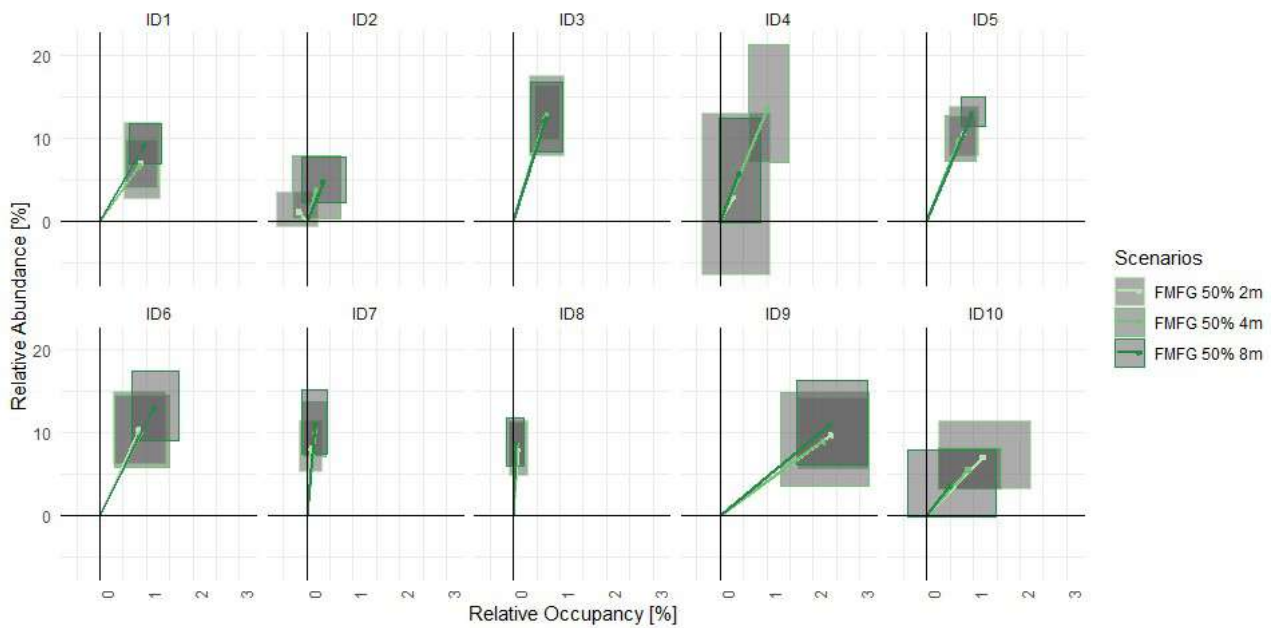


Figure 2.10 Mixed field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.5 Flower, grassy and mixed field margins

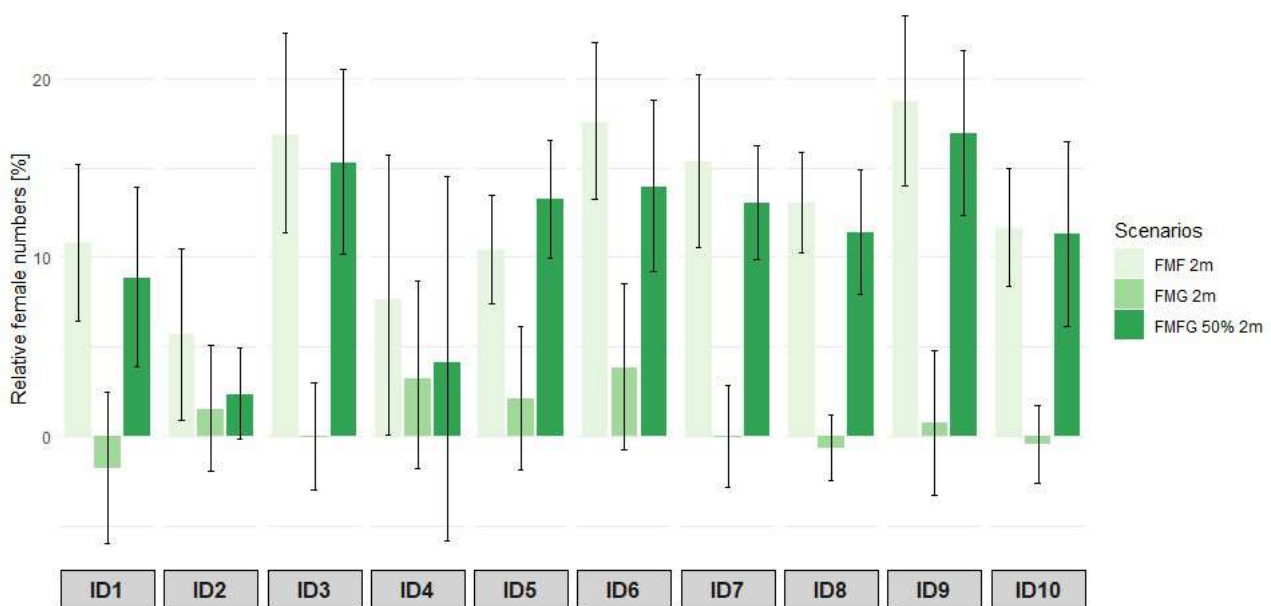


Figure 2.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

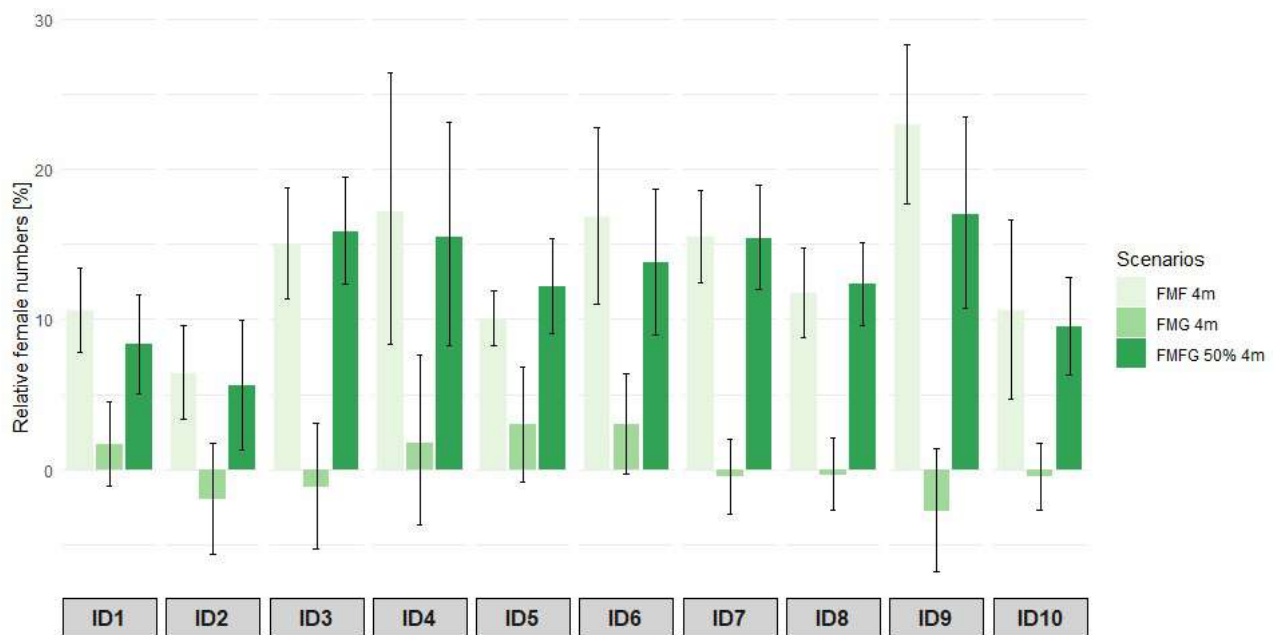


Figure 2.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

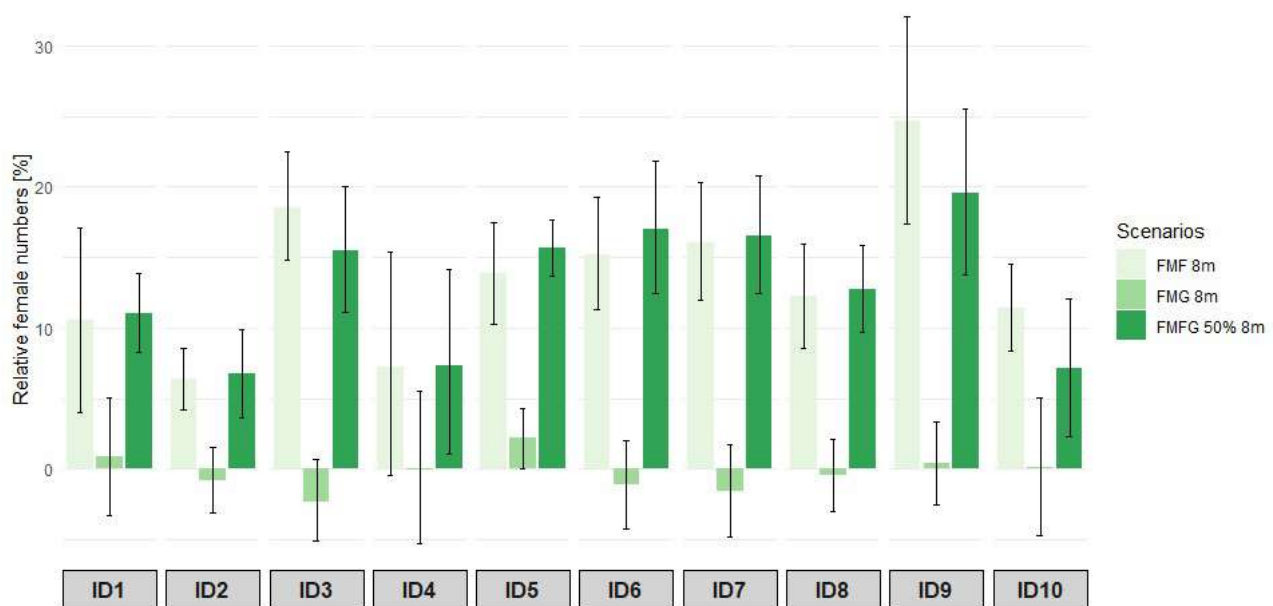


Figure 2.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

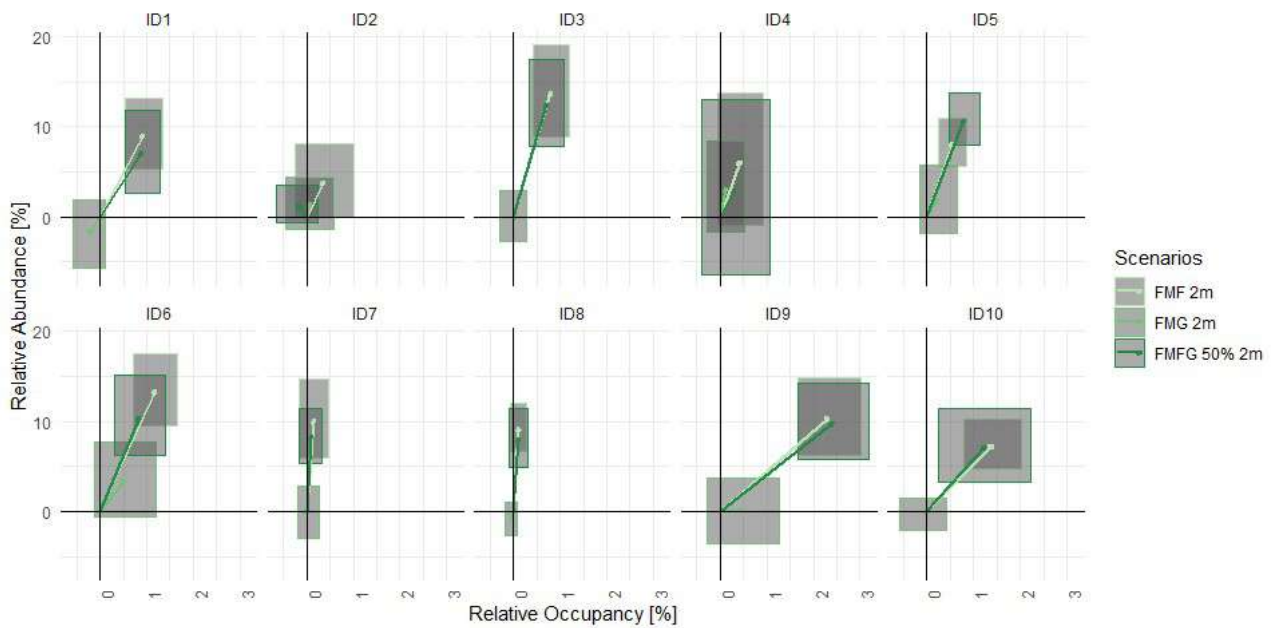


Figure 2.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

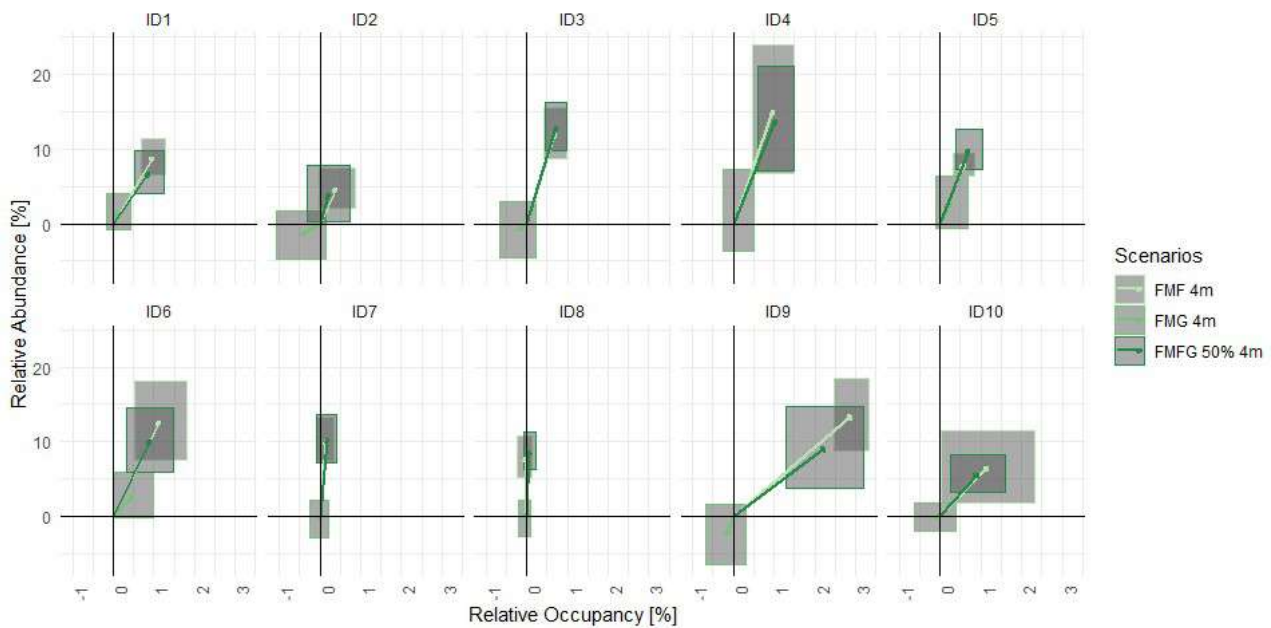


Figure 2.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes..

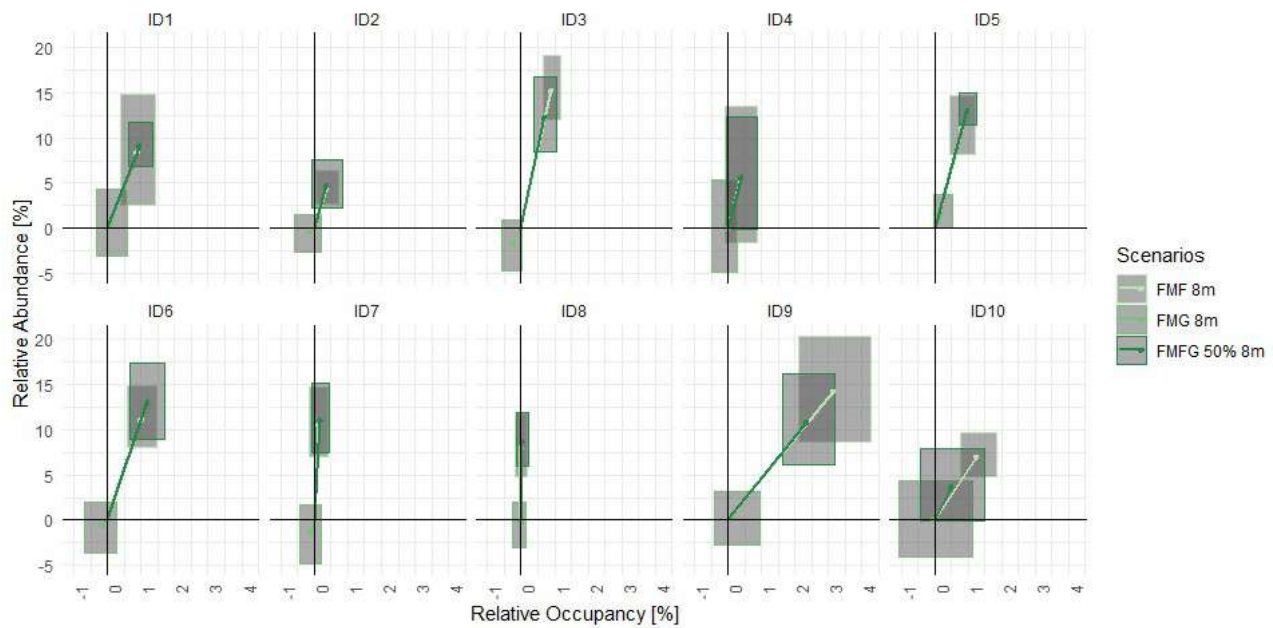


Figure 2.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.6 Setaside

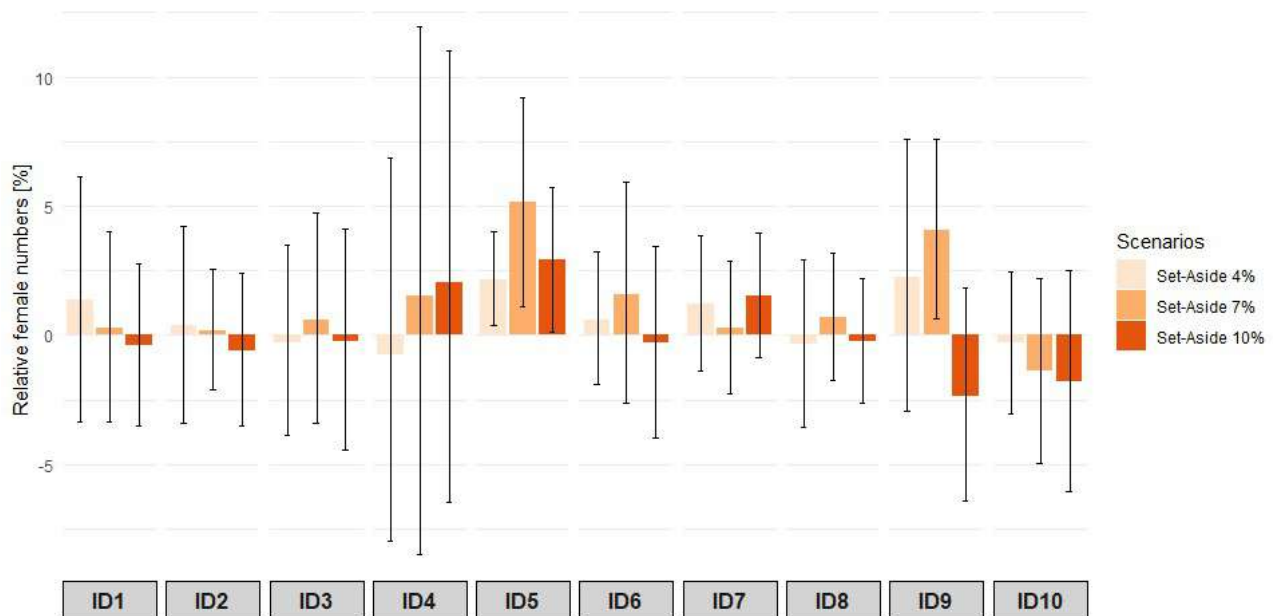


Figure 2.17 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

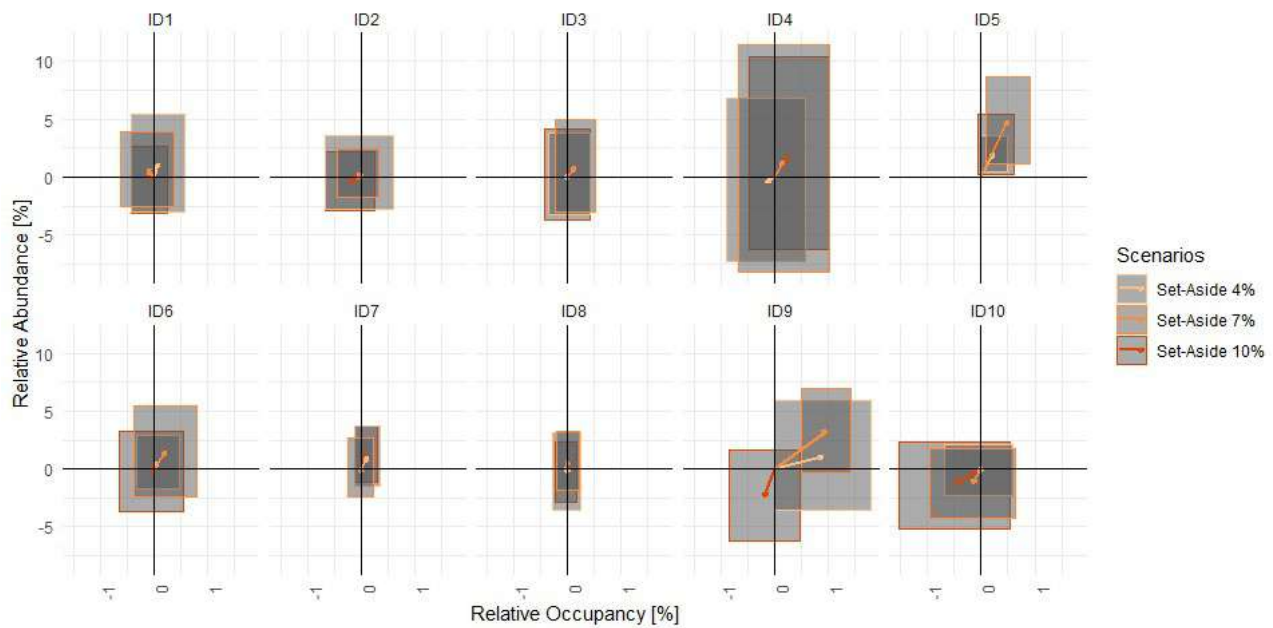


Figure 2.18 Setaside scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.7 Legume

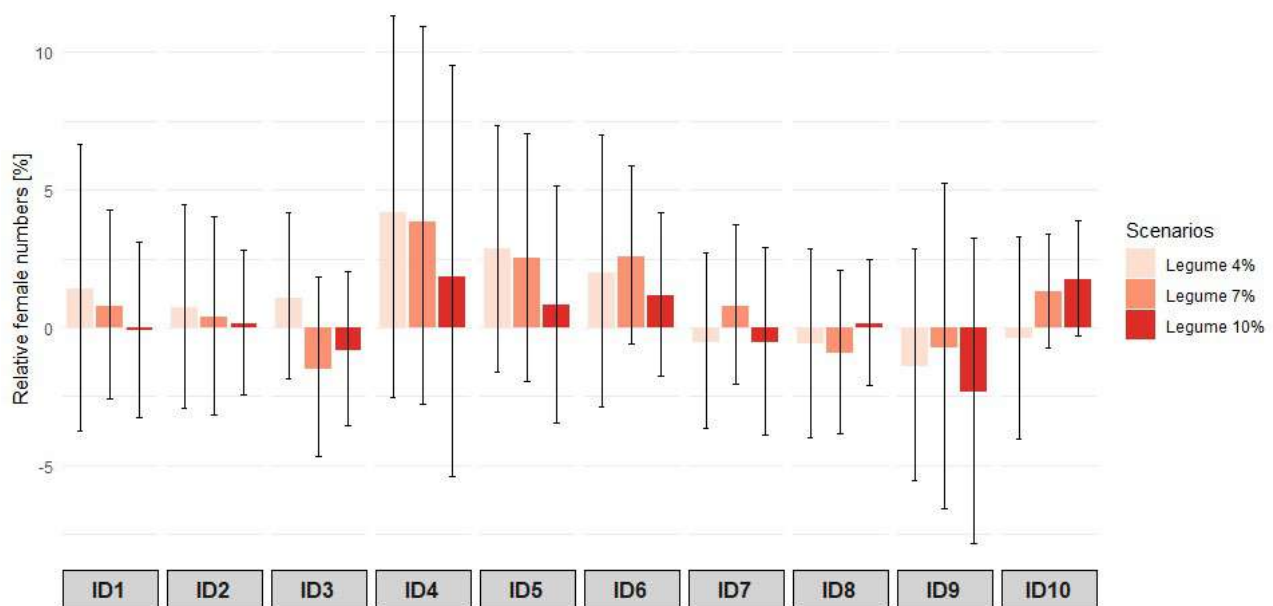


Figure 2.19 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

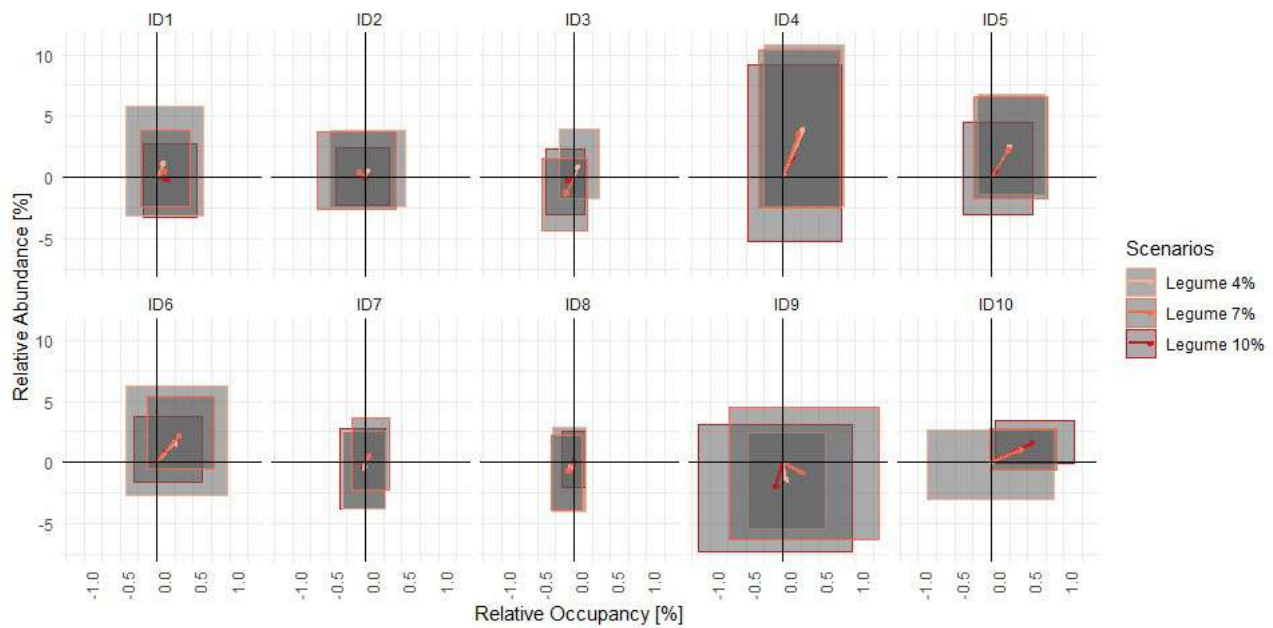


Figure 2.20 Legume scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.2.8 Biopesticides

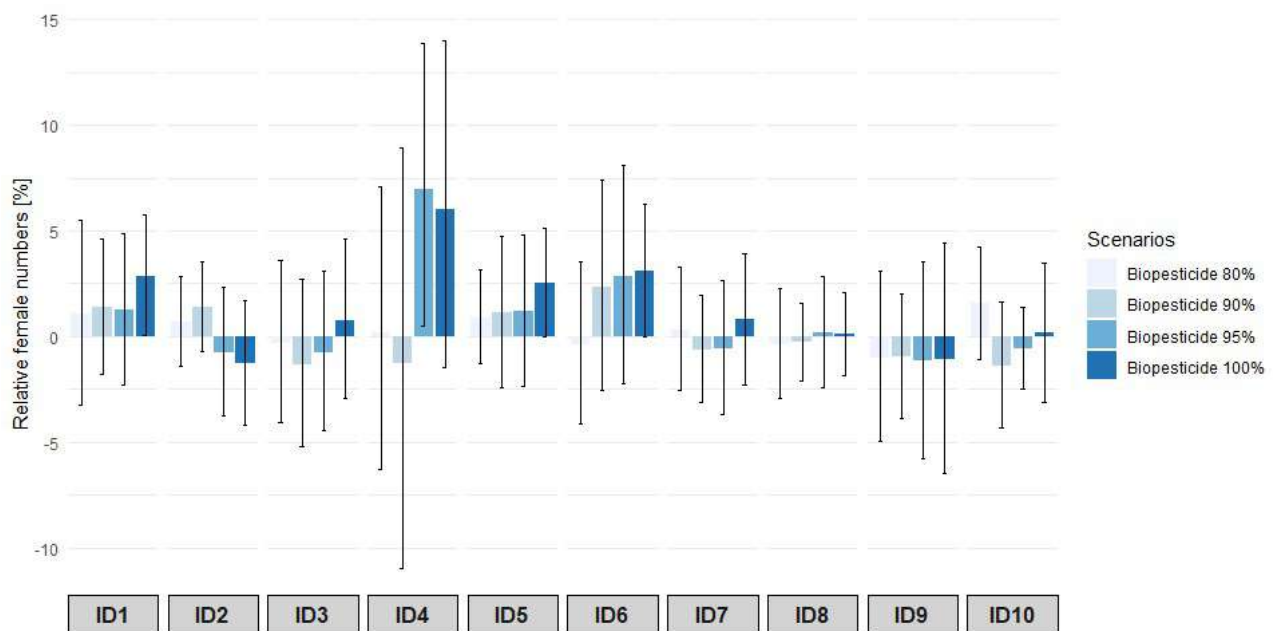


Figure 2.21 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

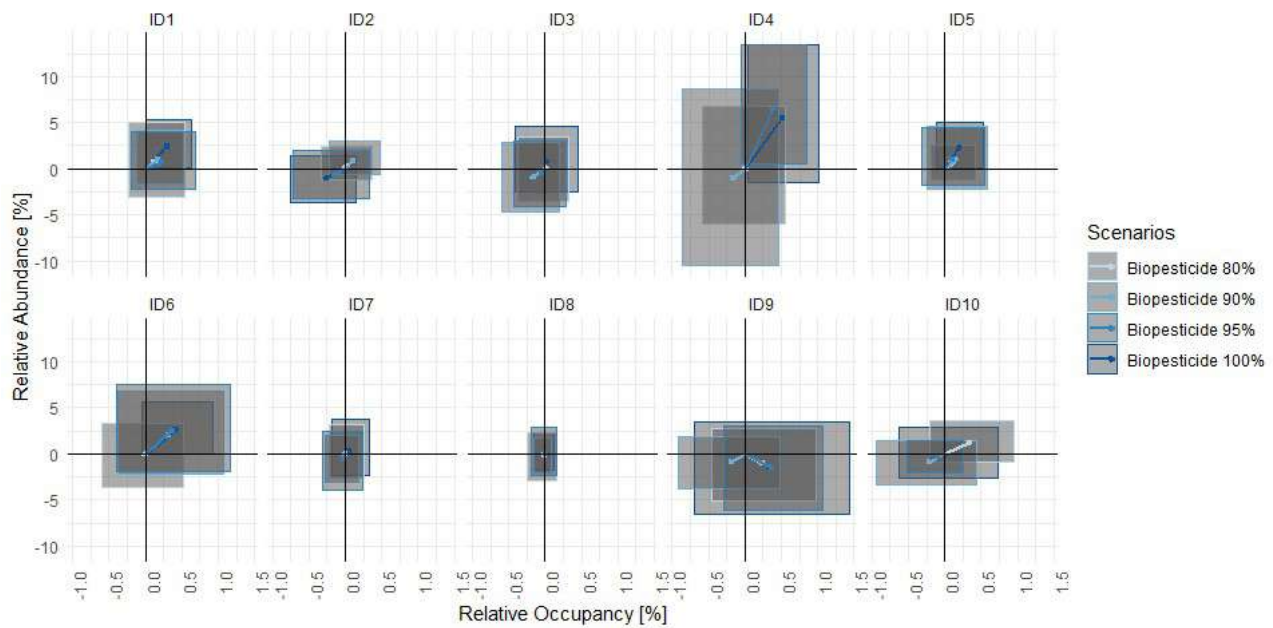


Figure 2.22 Biopesticide scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3 Denmark

2.3.1 Crop diversification

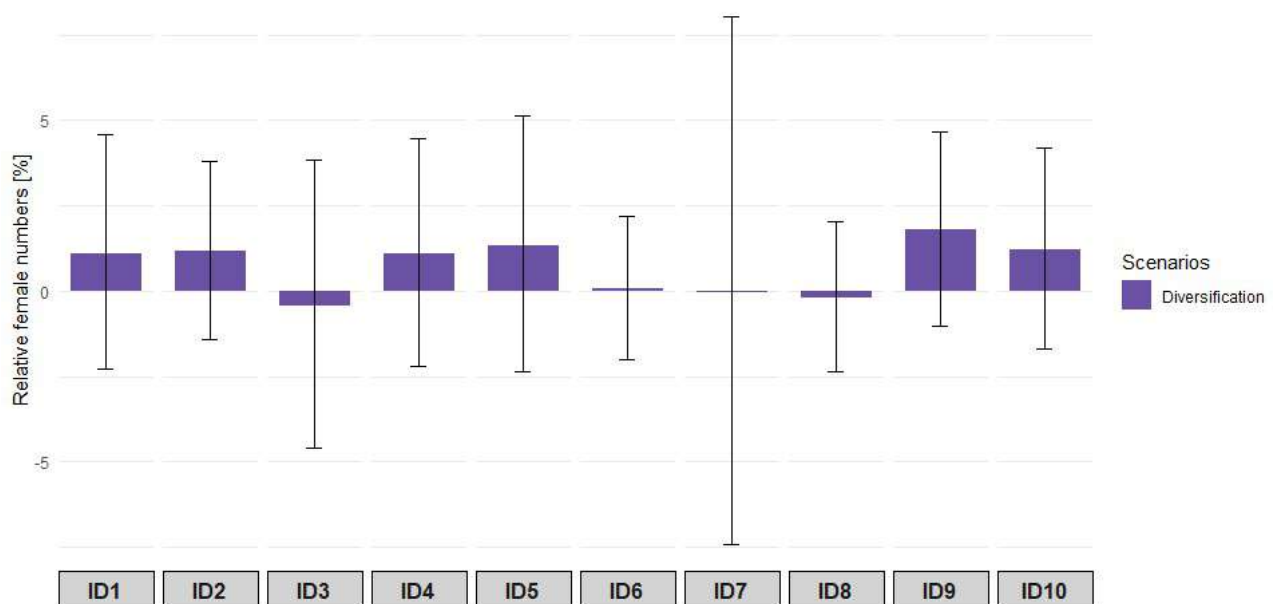


Figure 2.23 Diversification scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

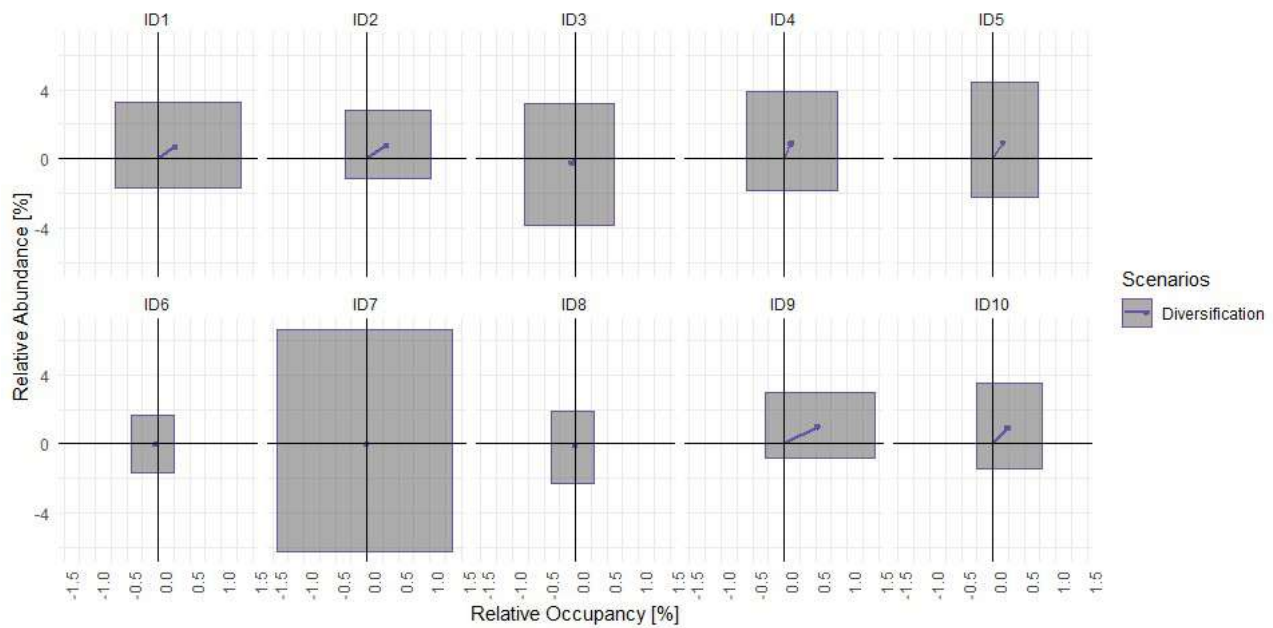


Figure 2.24 Diversification scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.2 Flower field margins

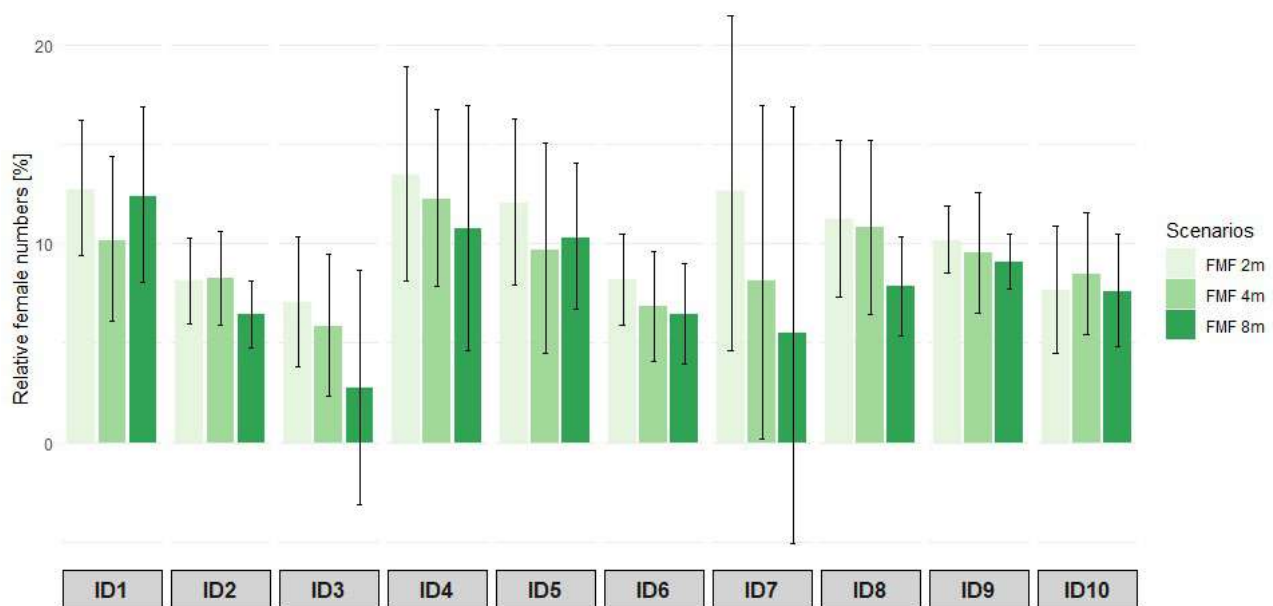


Figure 2.25 Flower field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

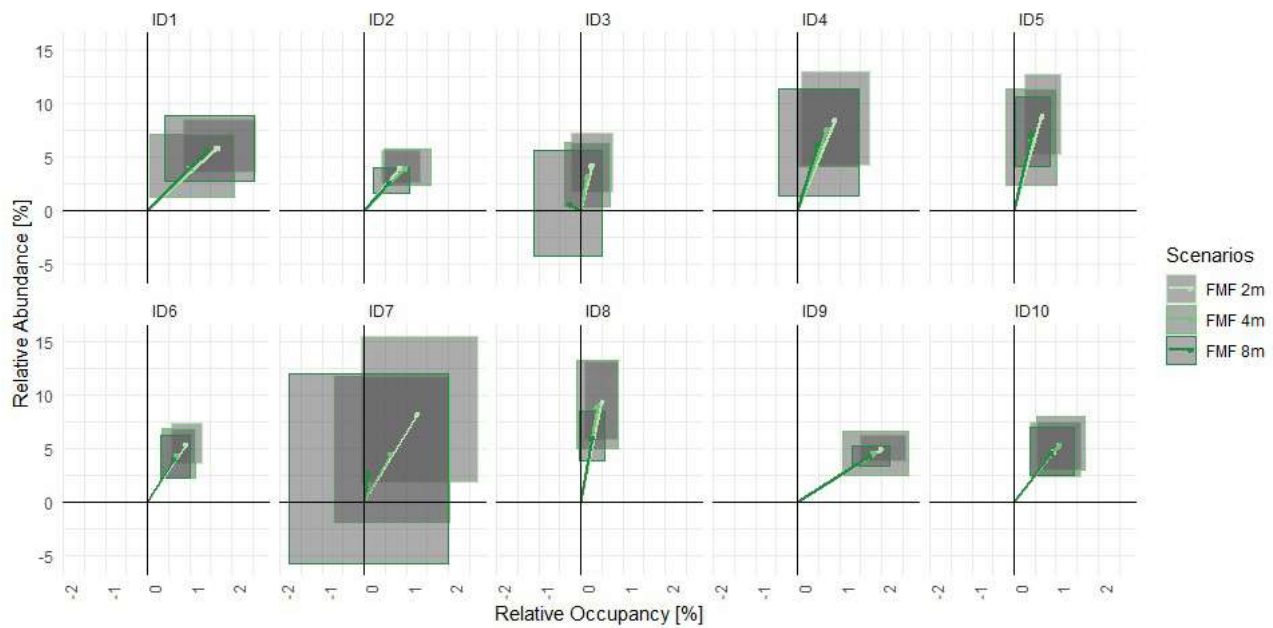


Figure 2.26 Flower field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.3 Grassy field margins

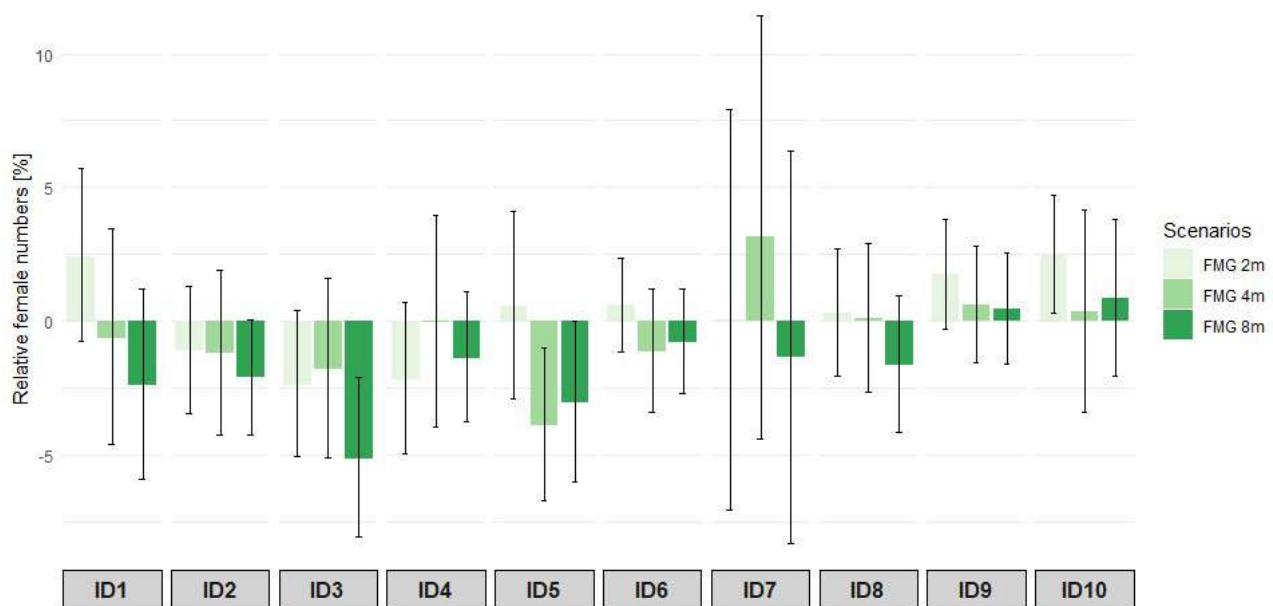


Figure 2.27 Grassy field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

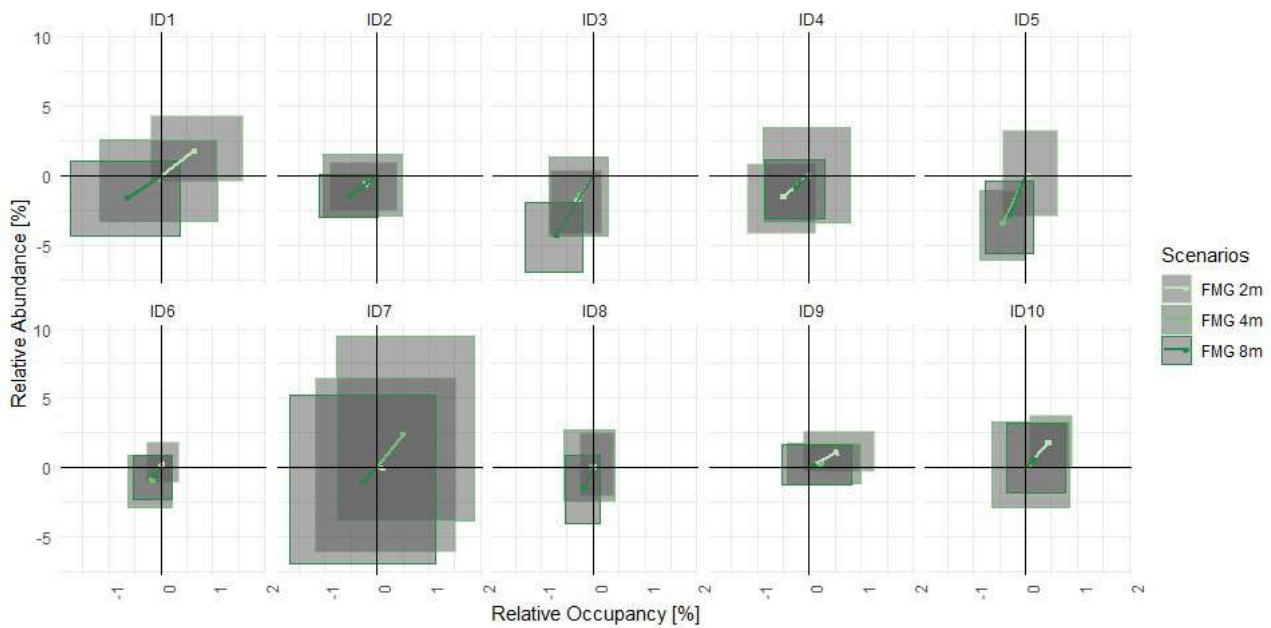


Figure 2.28 Grassy field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.4 Mixed field margins

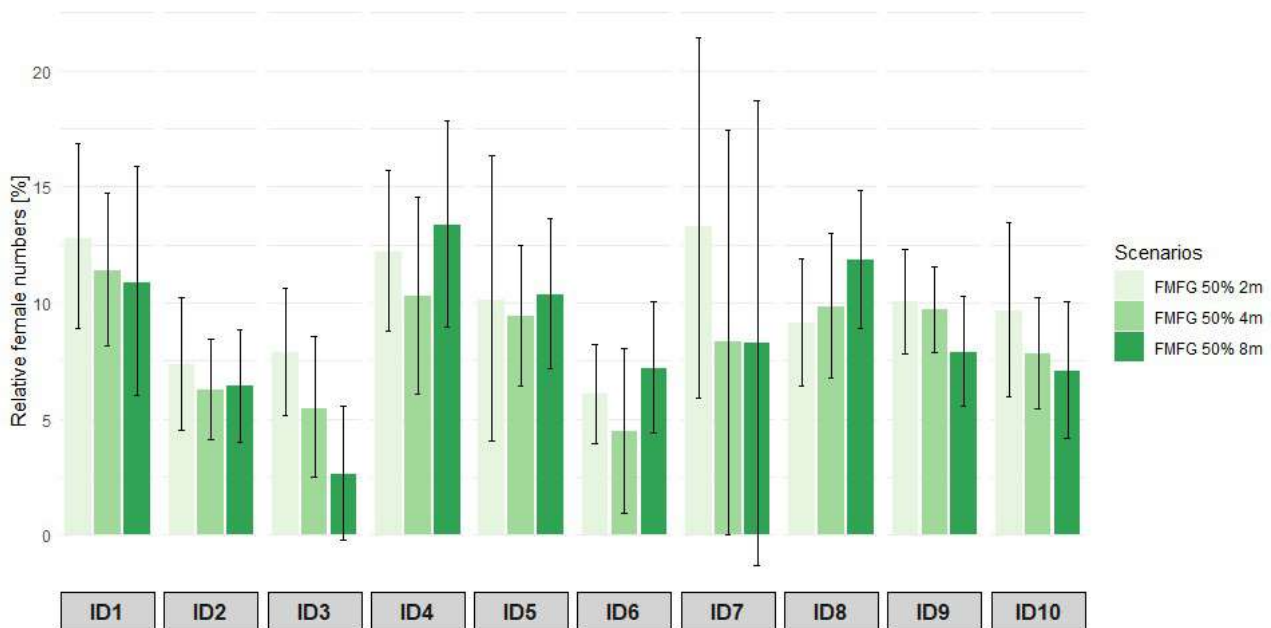


Figure 2.29 Mixed field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

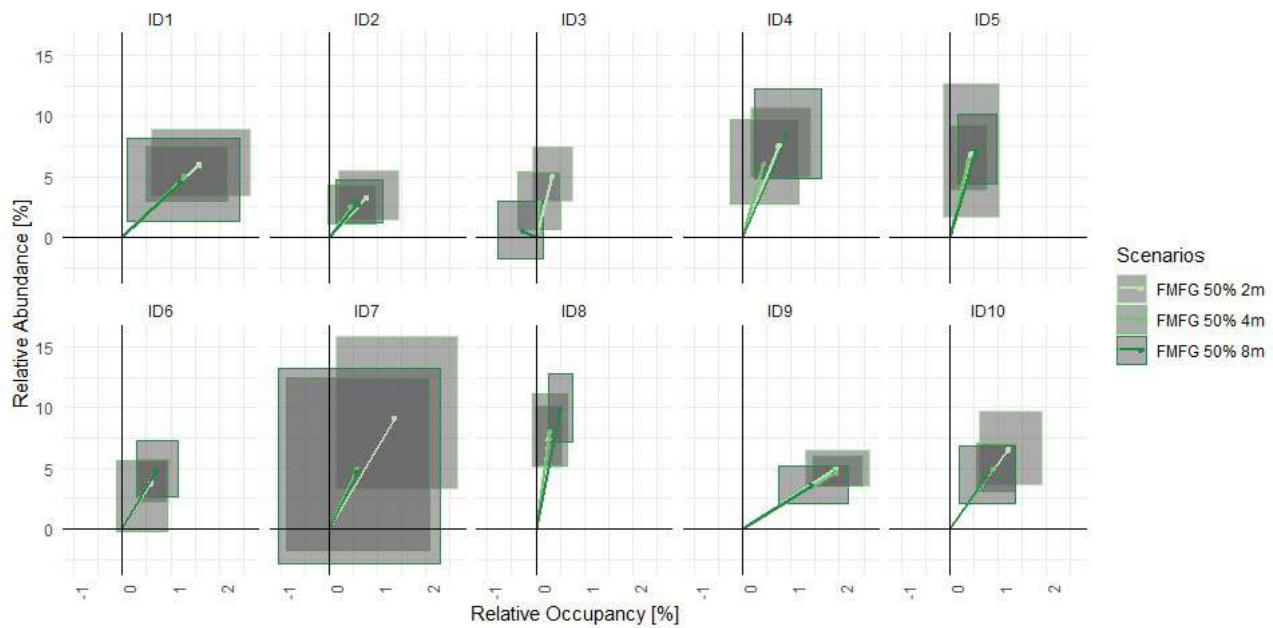


Figure 2.30 Mixed field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.5 Flower, grassy and mixed field margins

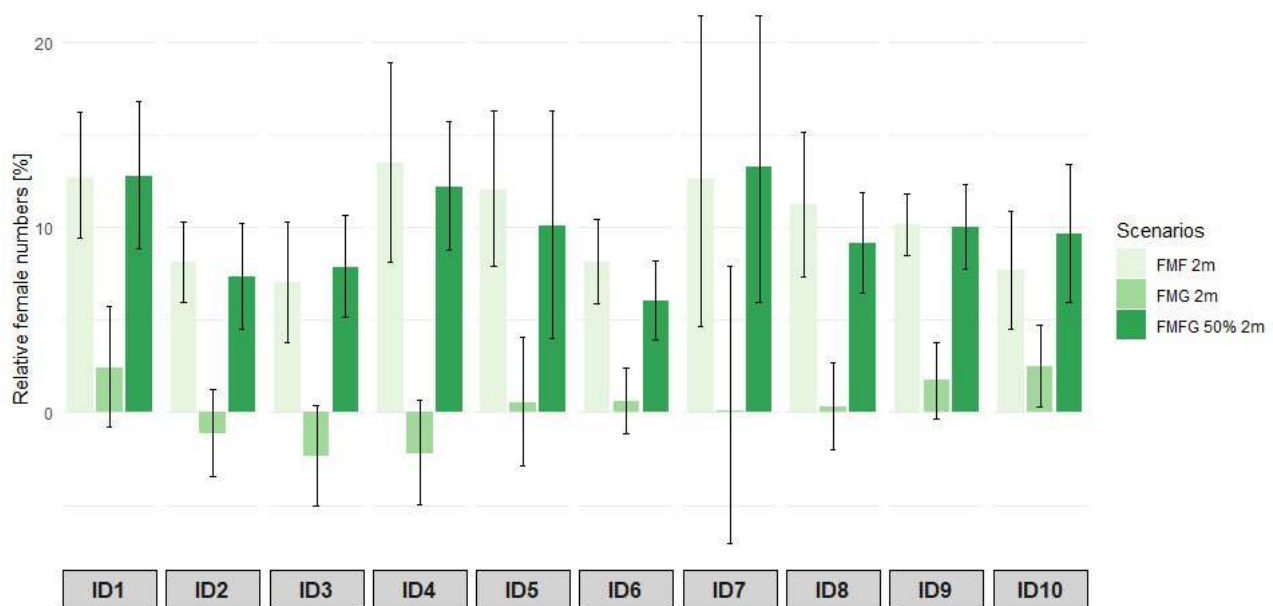


Figure 2.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

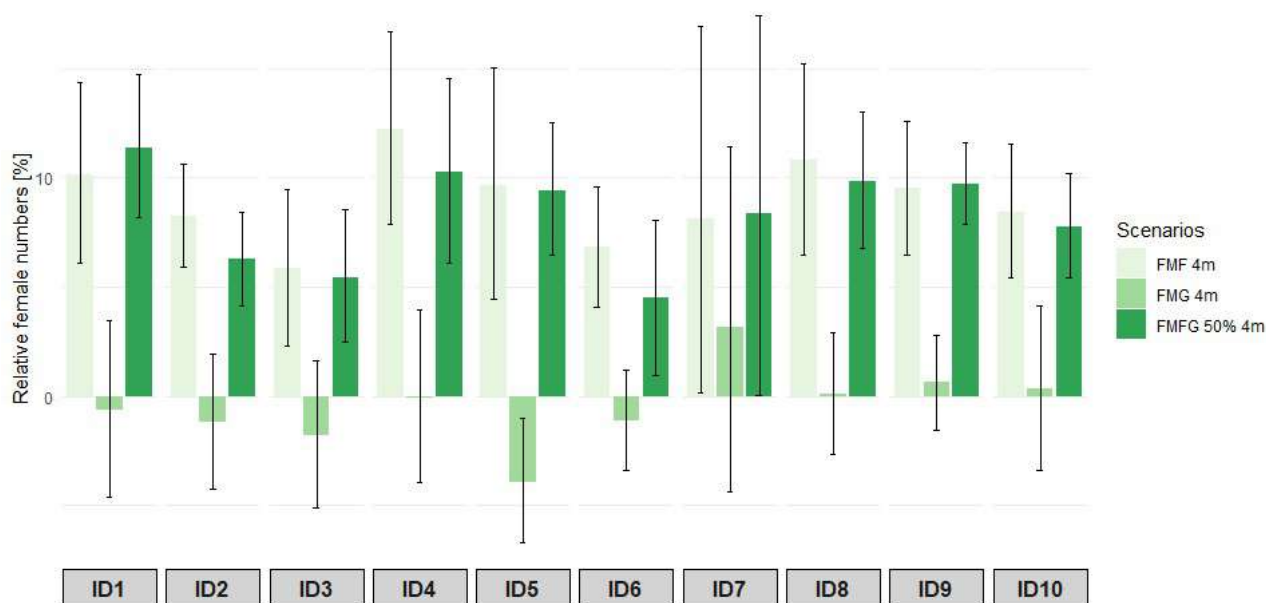


Figure 2.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

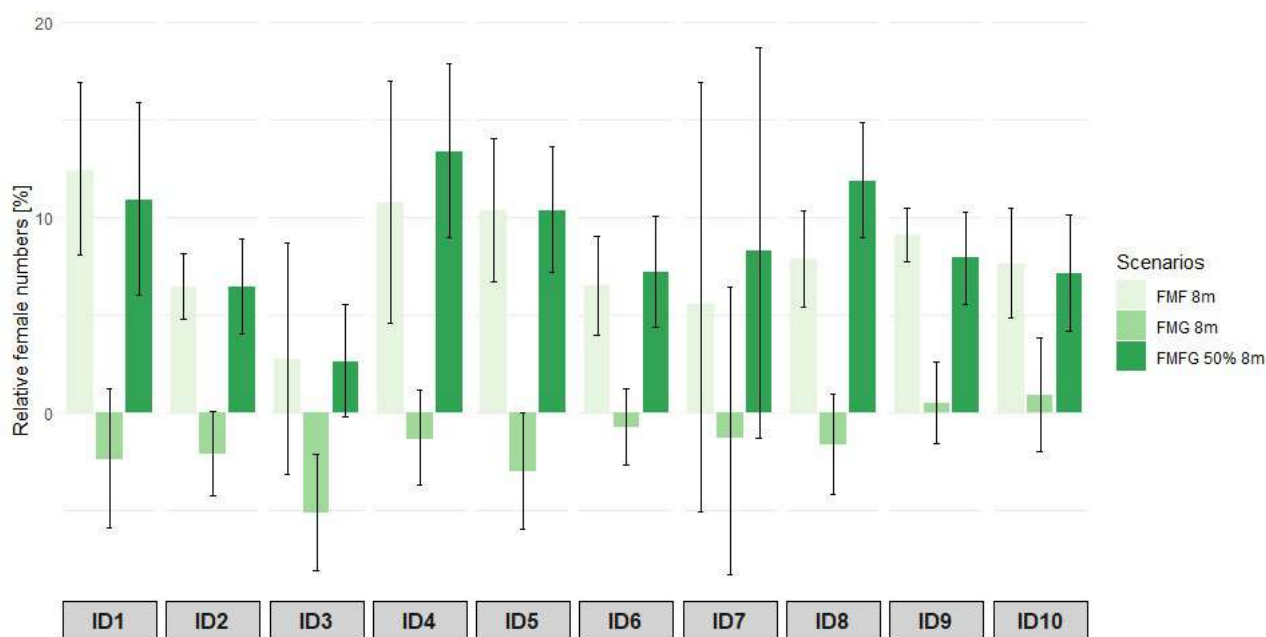


Figure 2.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

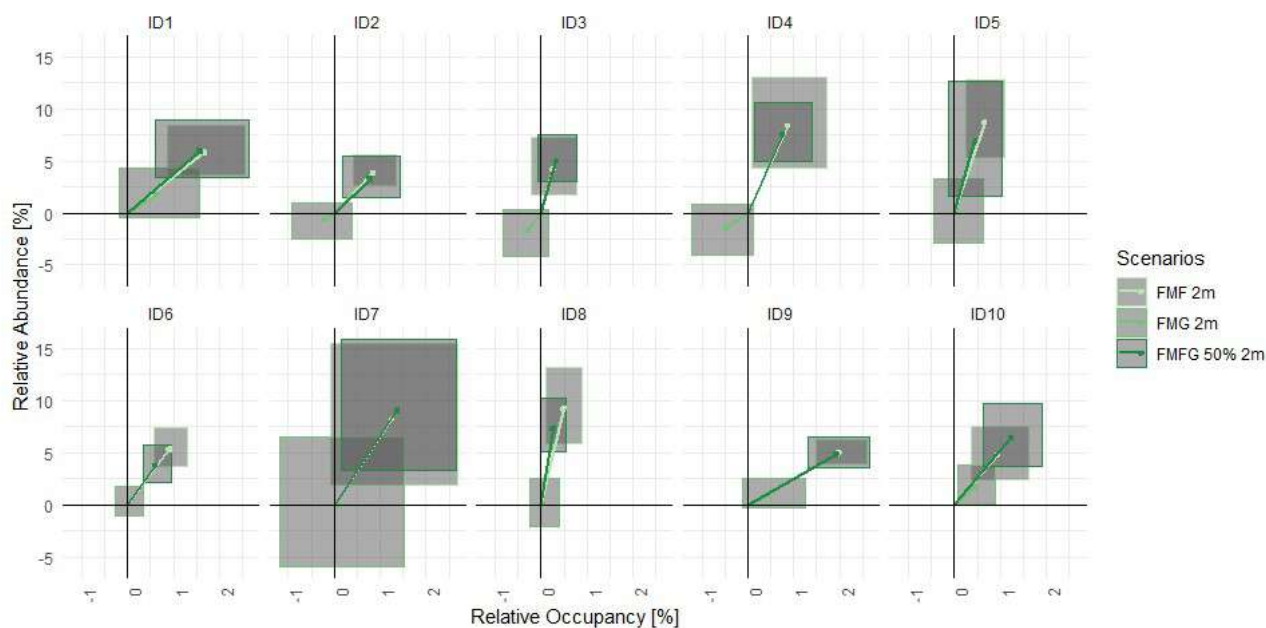


Figure 2.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

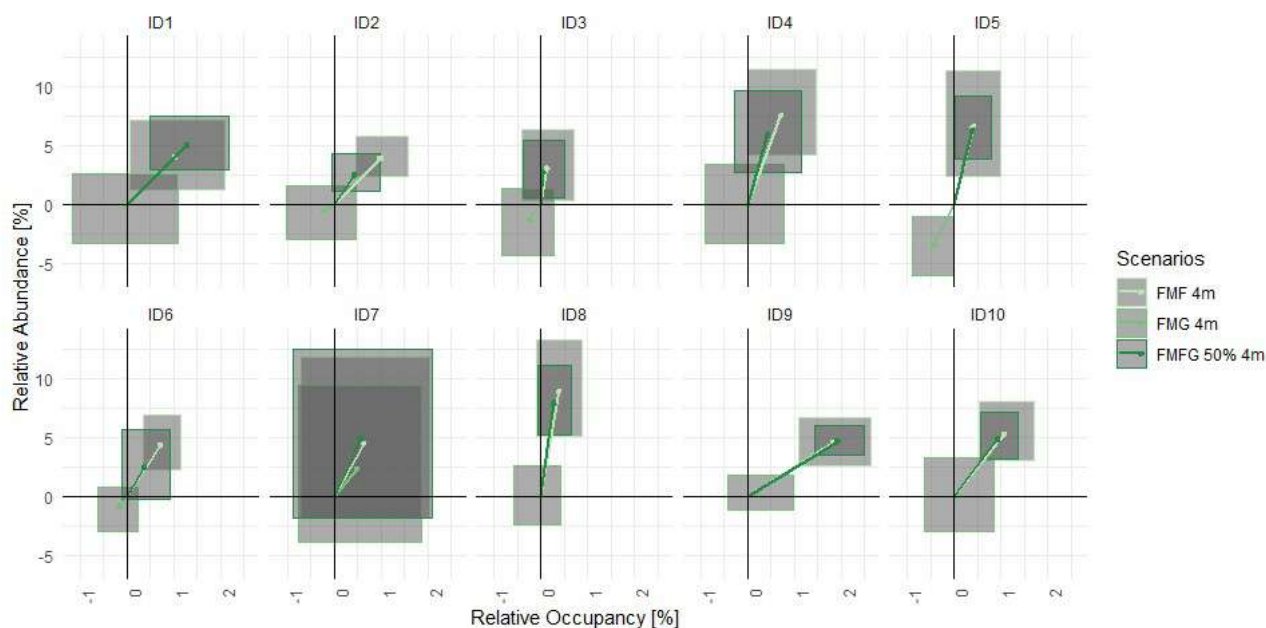


Figure 2.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes..

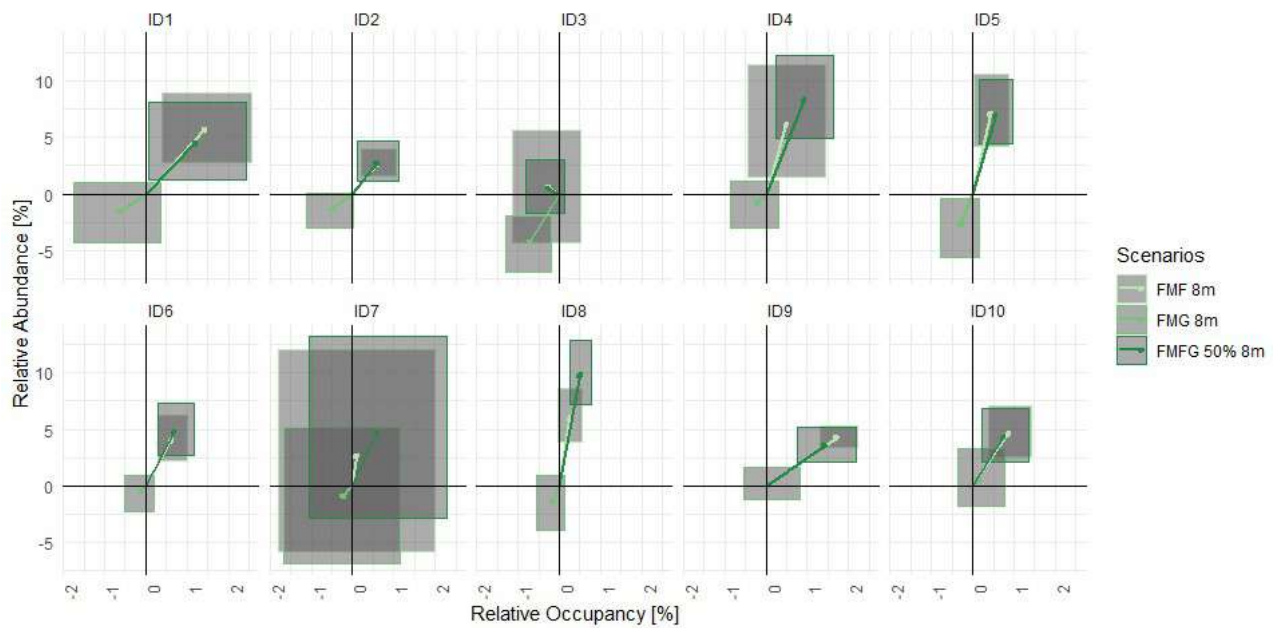


Figure 2.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.6 Setaside

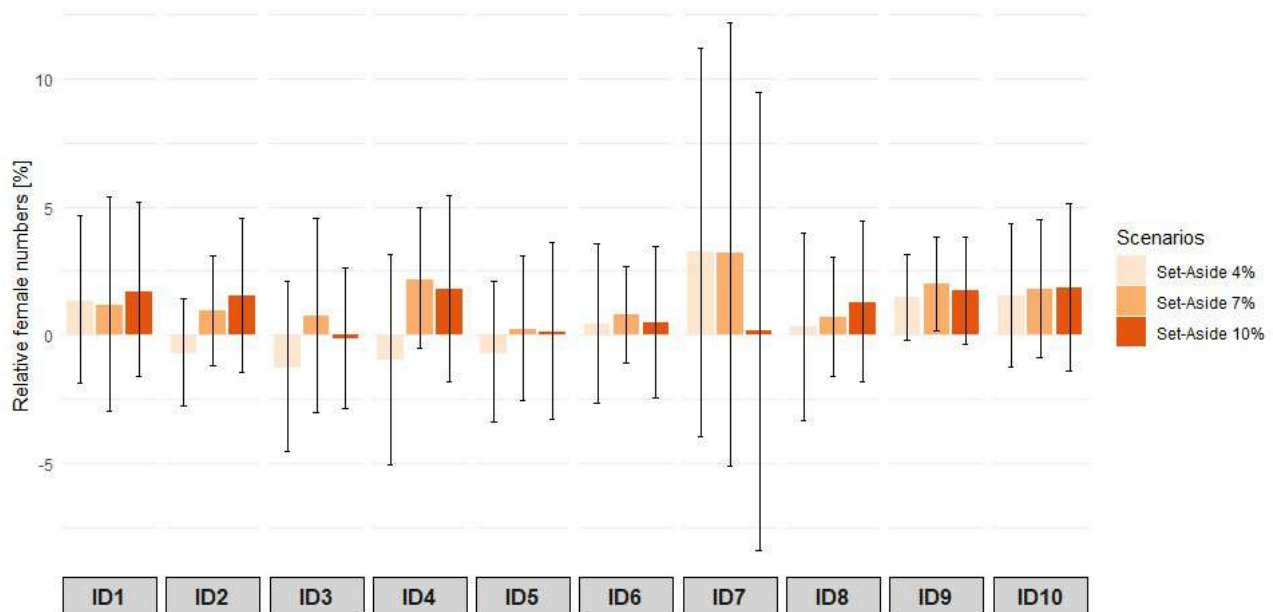


Figure 2.37 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

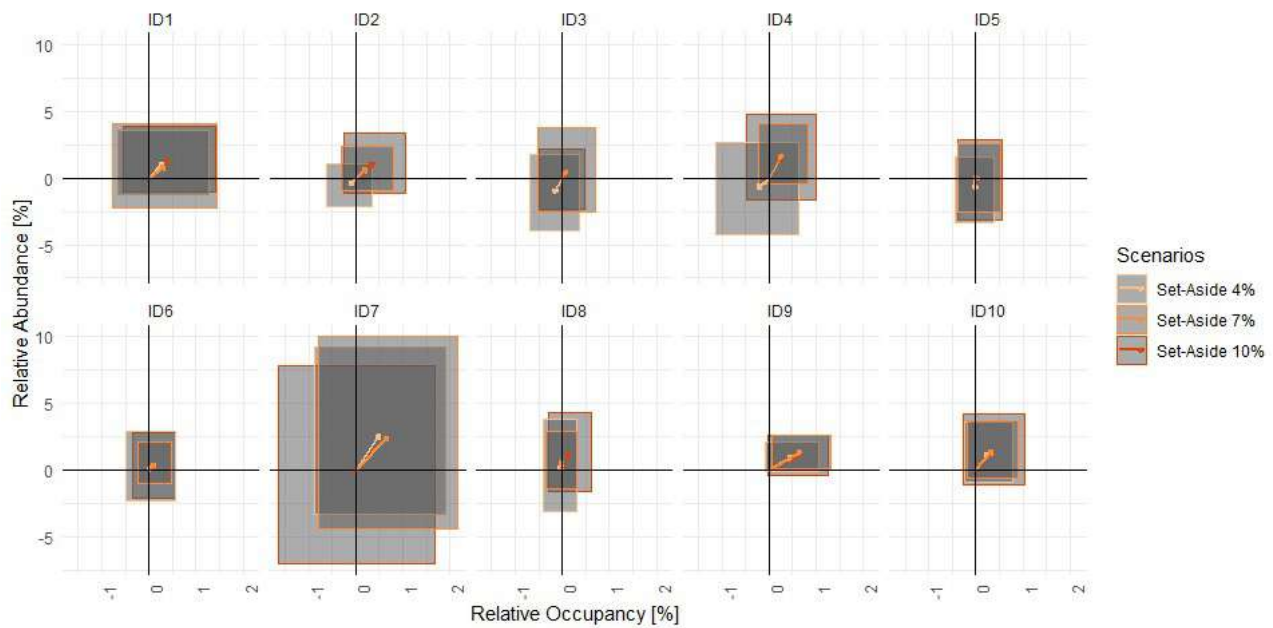


Figure 2.38 Setaside scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.7 Legume

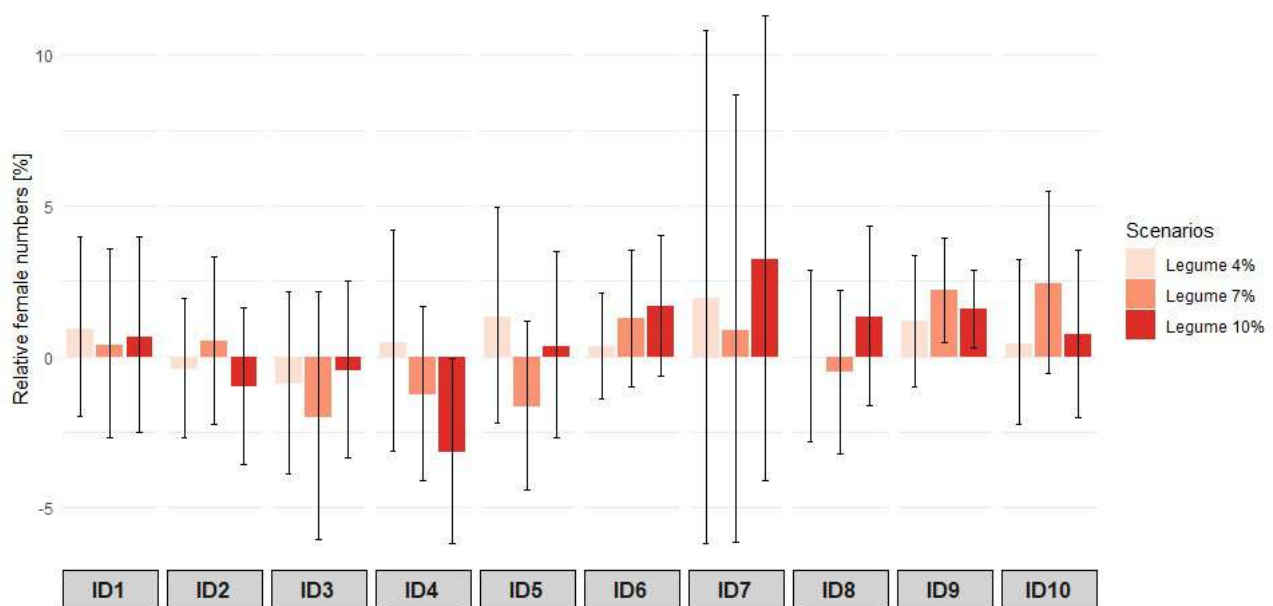


Figure 2.39 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

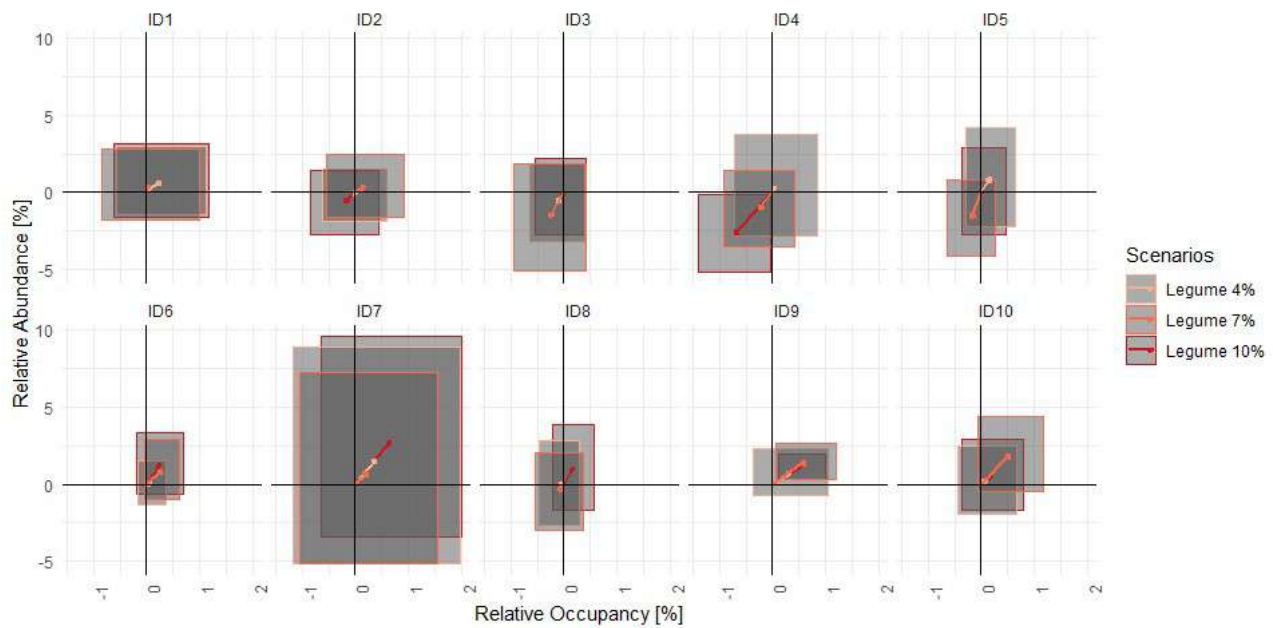


Figure 2.40 Legume scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.3.8 Biopesticides

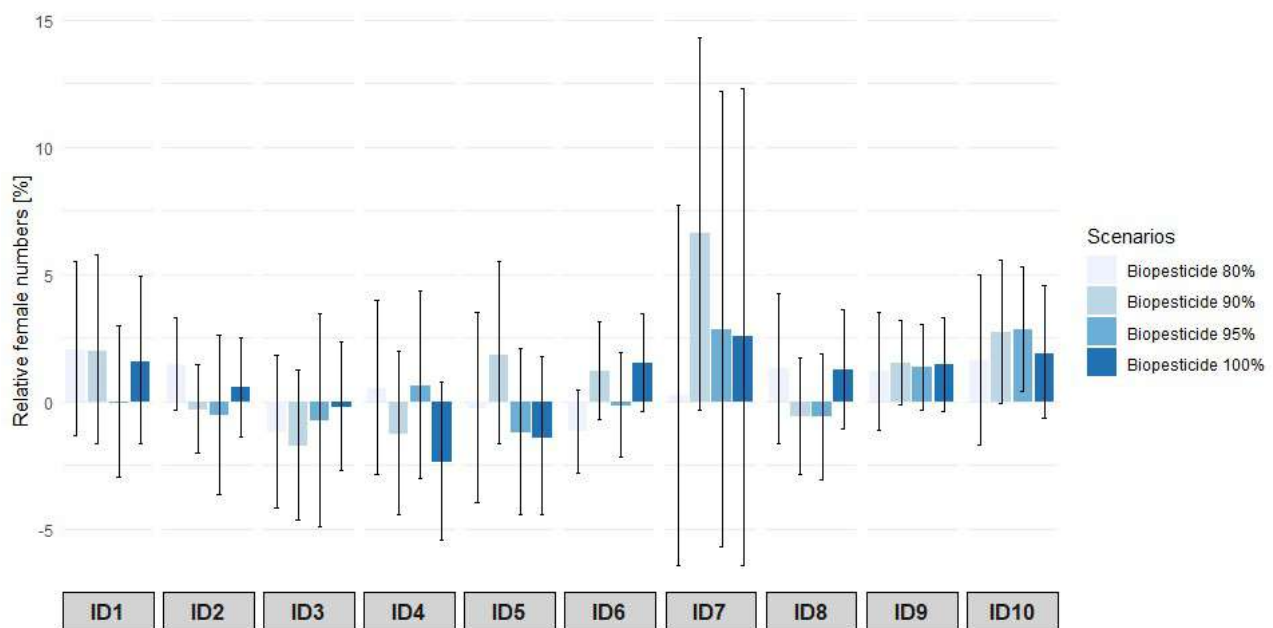


Figure 2.41 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

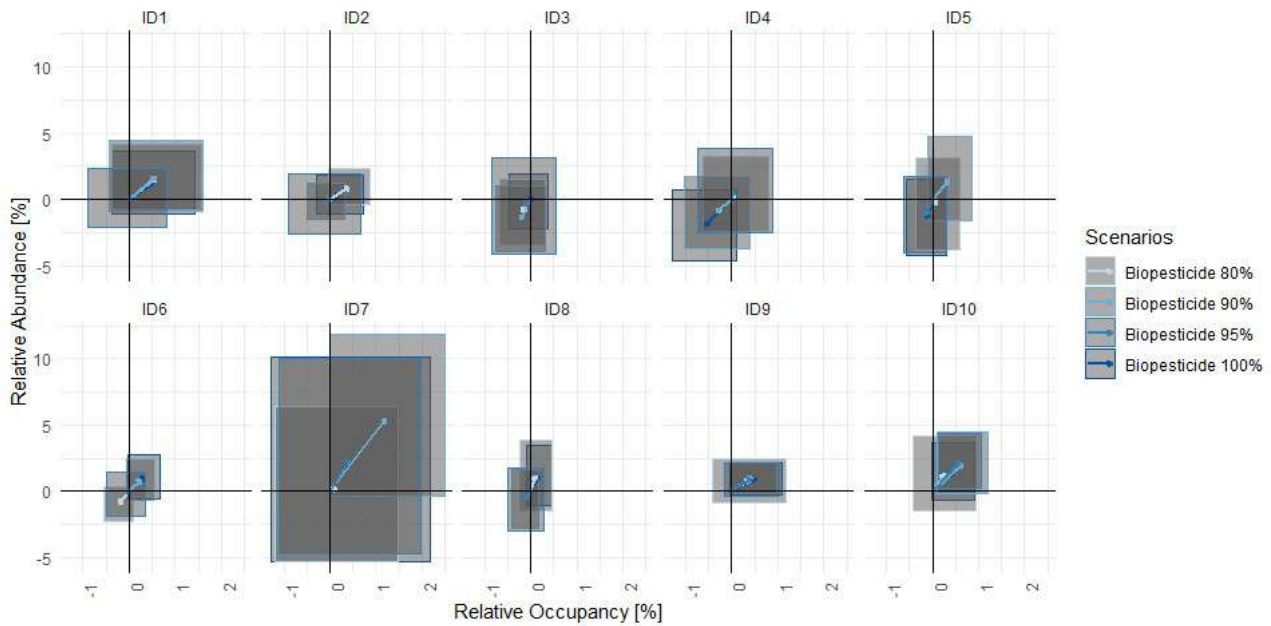


Figure 2.42 Biopesticide scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4 Poland

2.4.1 Flower field margins

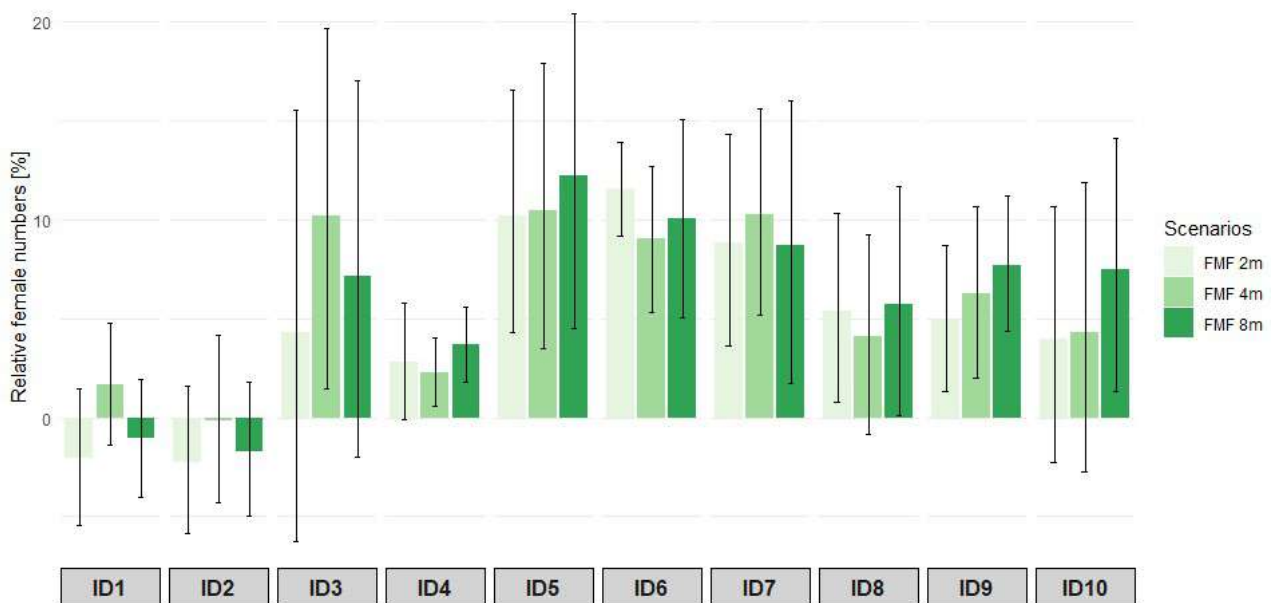


Figure 2.43 Flower field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

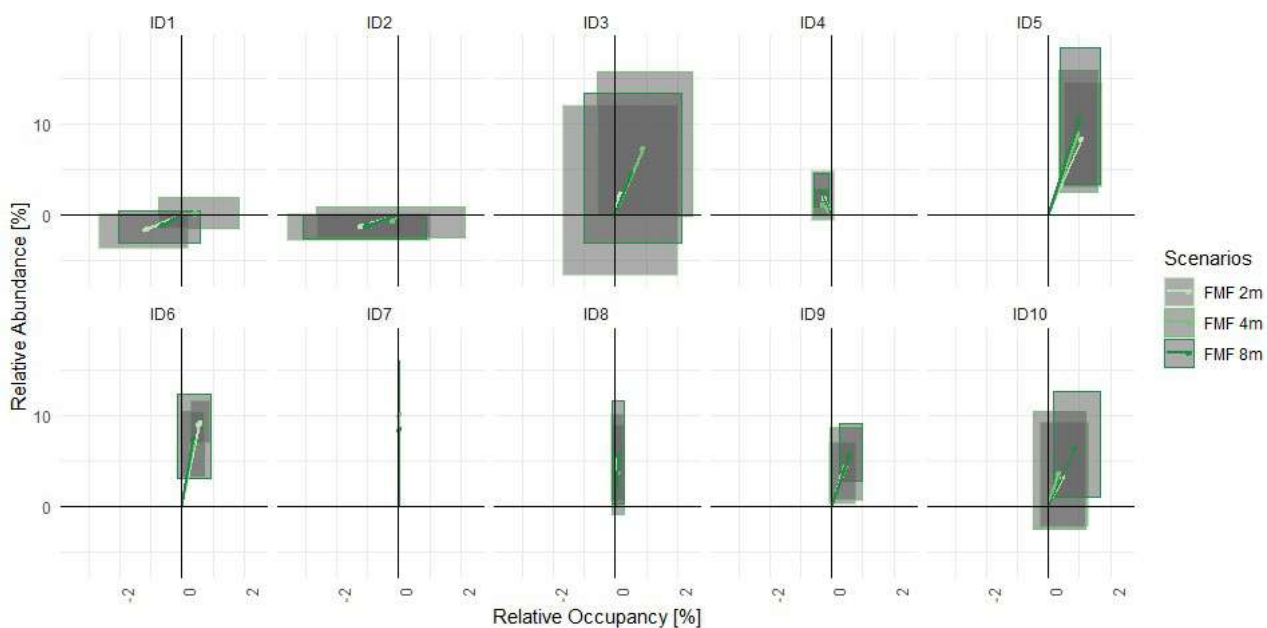


Figure 2.44 Flower field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4.2 Grassy field margins

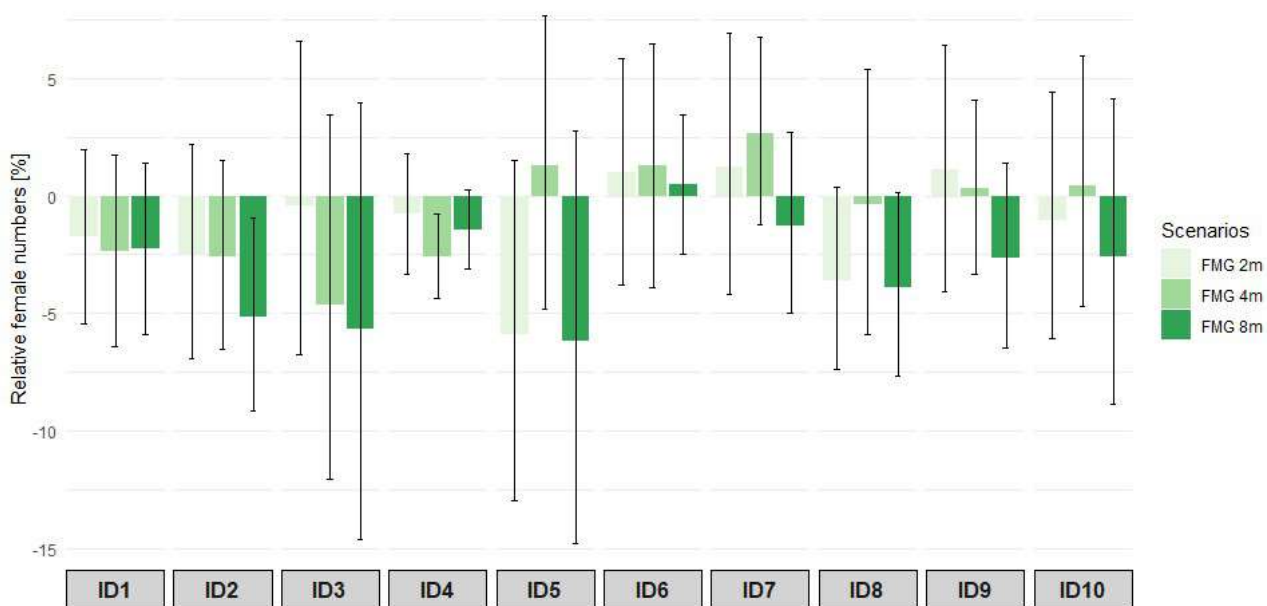


Figure 2.45 Grassy field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

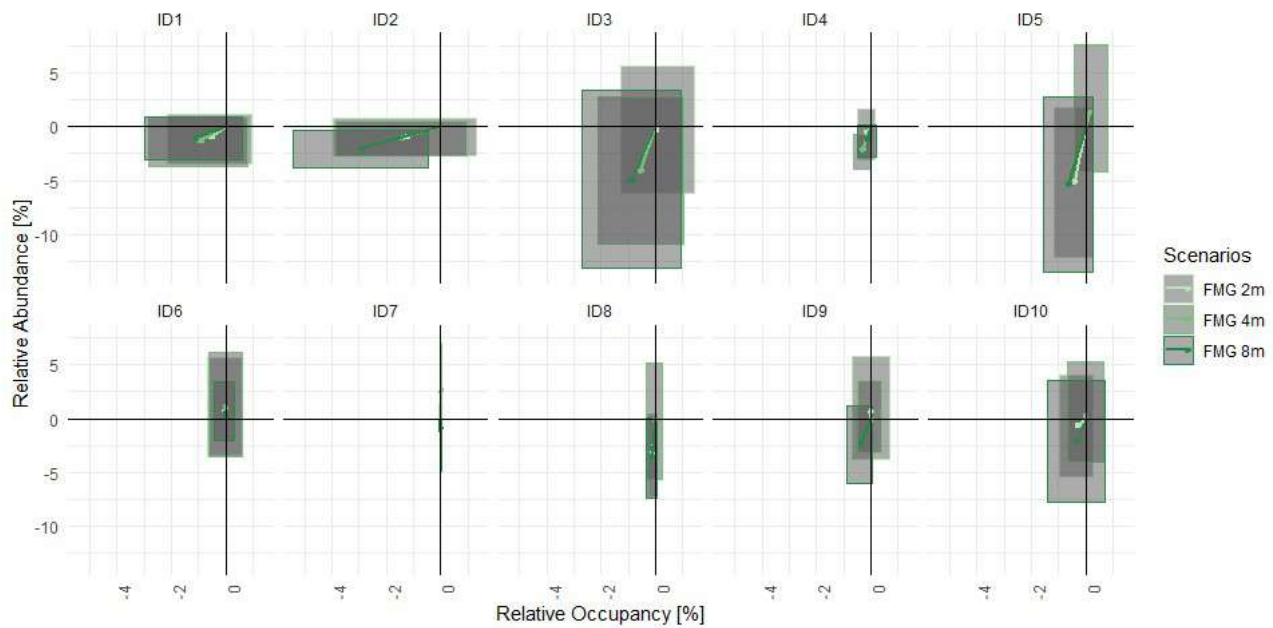


Figure 2.46 Grassy field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4.3 Mixed field margins

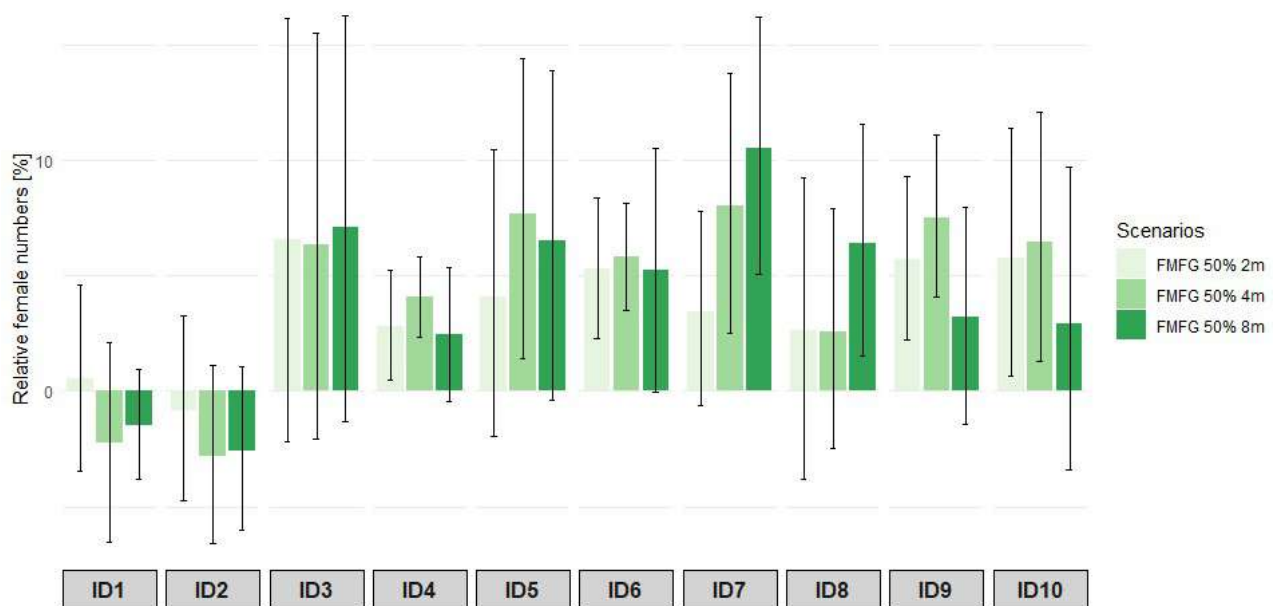


Figure 2.47 Mixed field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

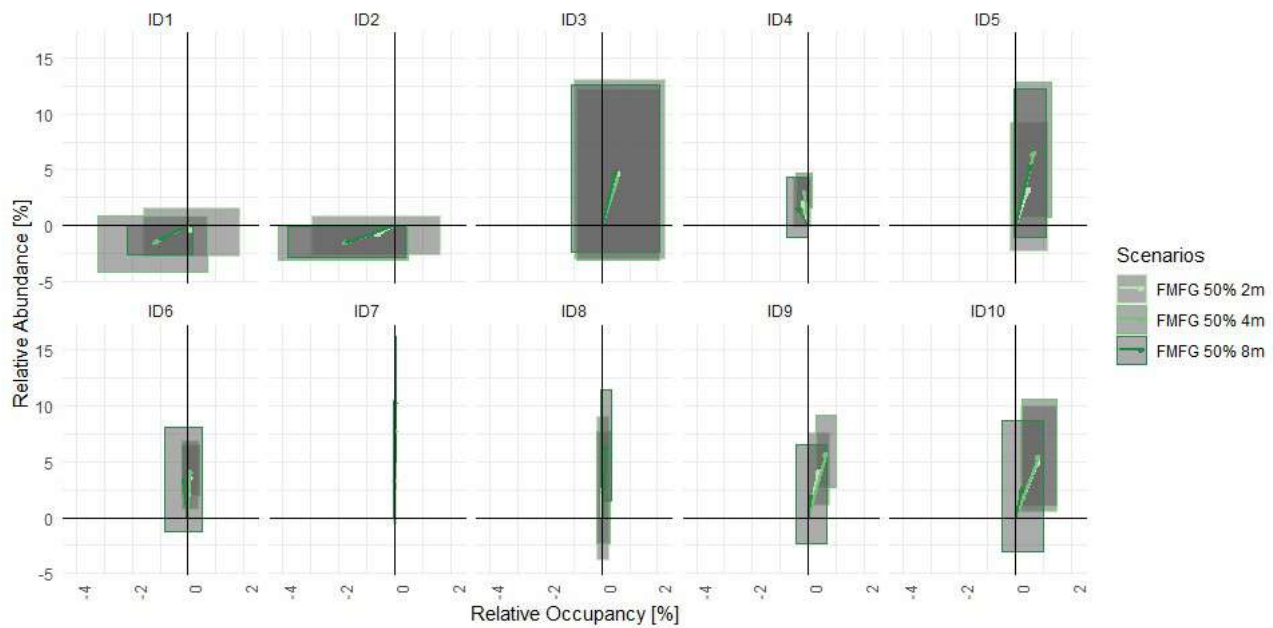


Figure 2.48 Mixed field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4.4 Flower, grassy and mixed field margins

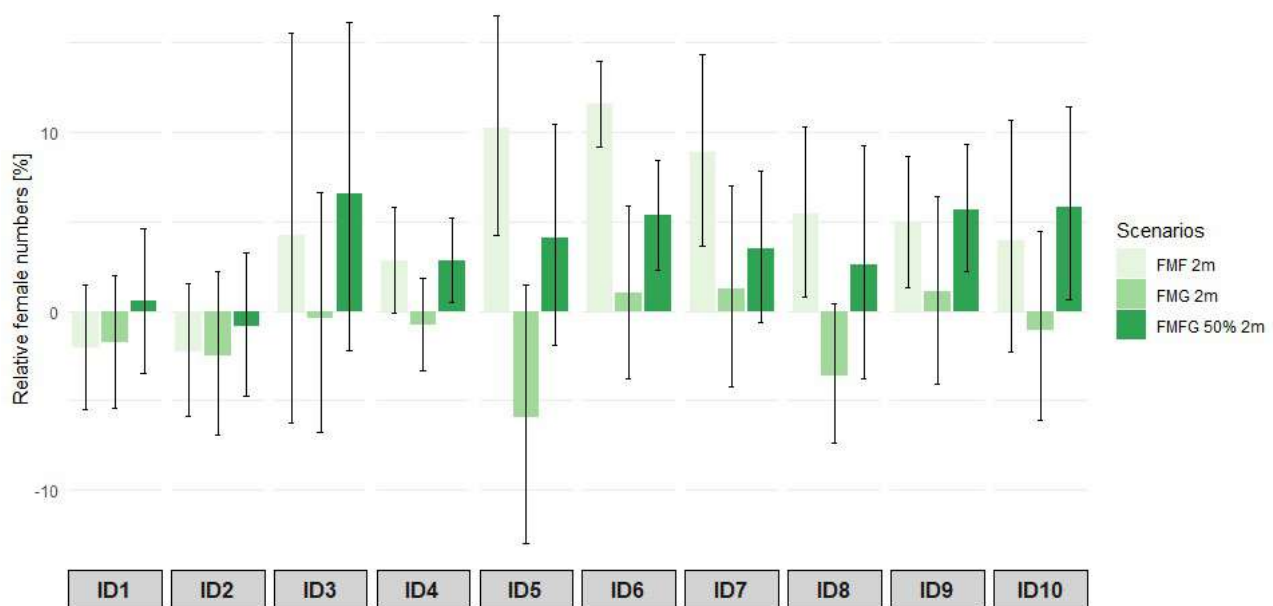


Figure 2.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

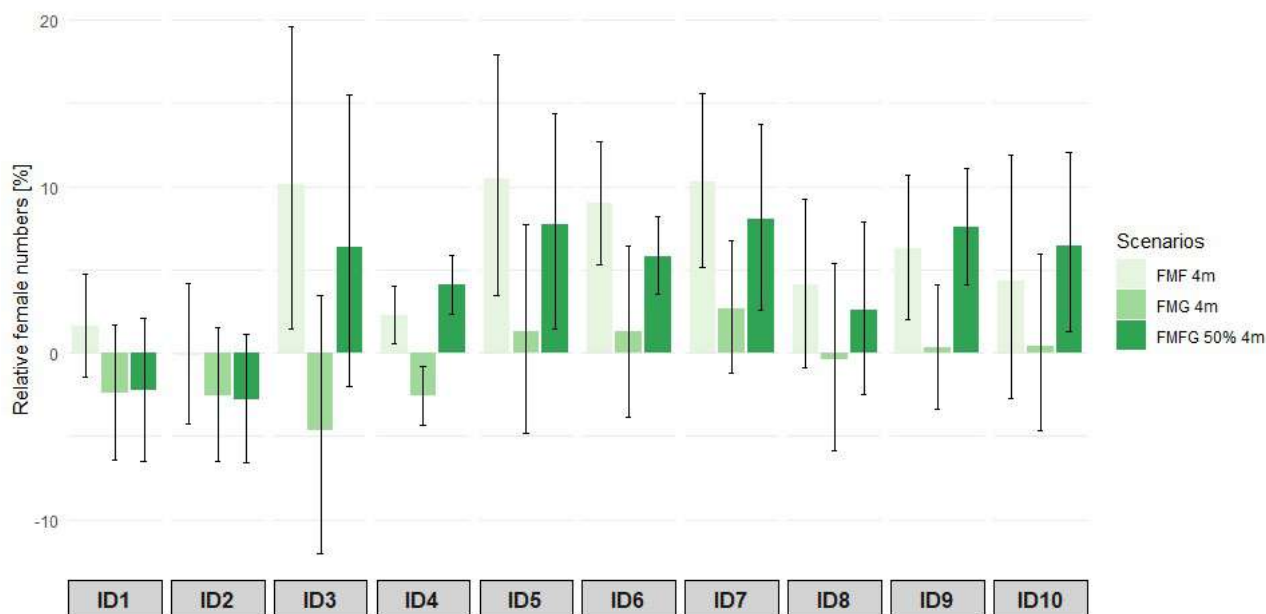


Figure 2.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

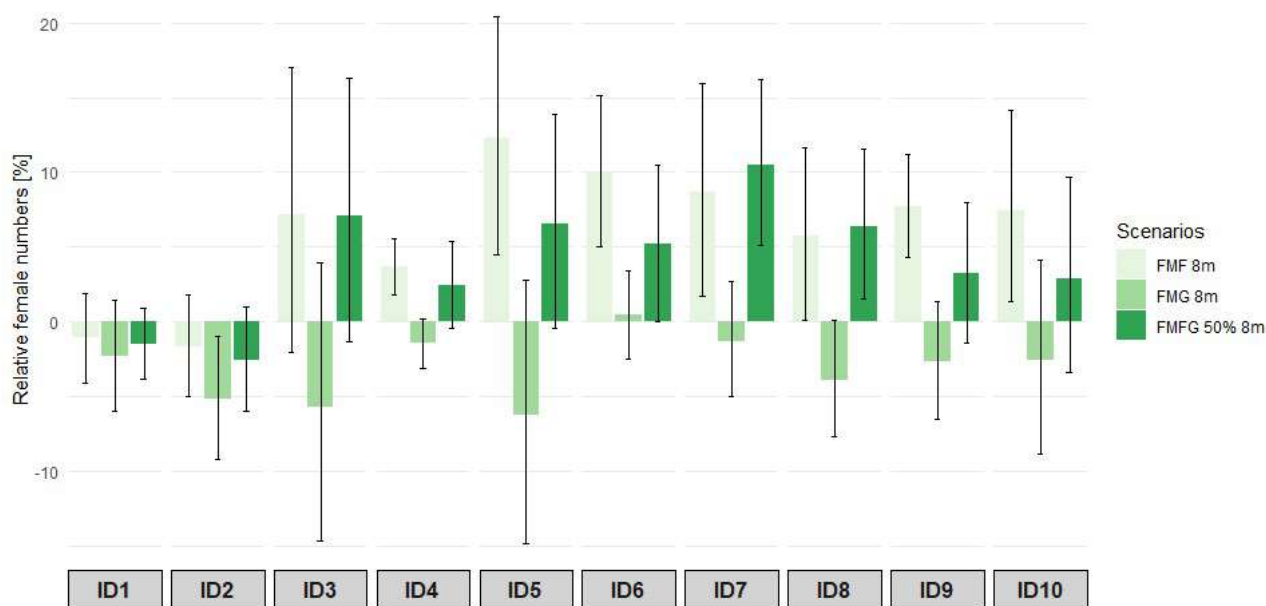


Figure 2.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

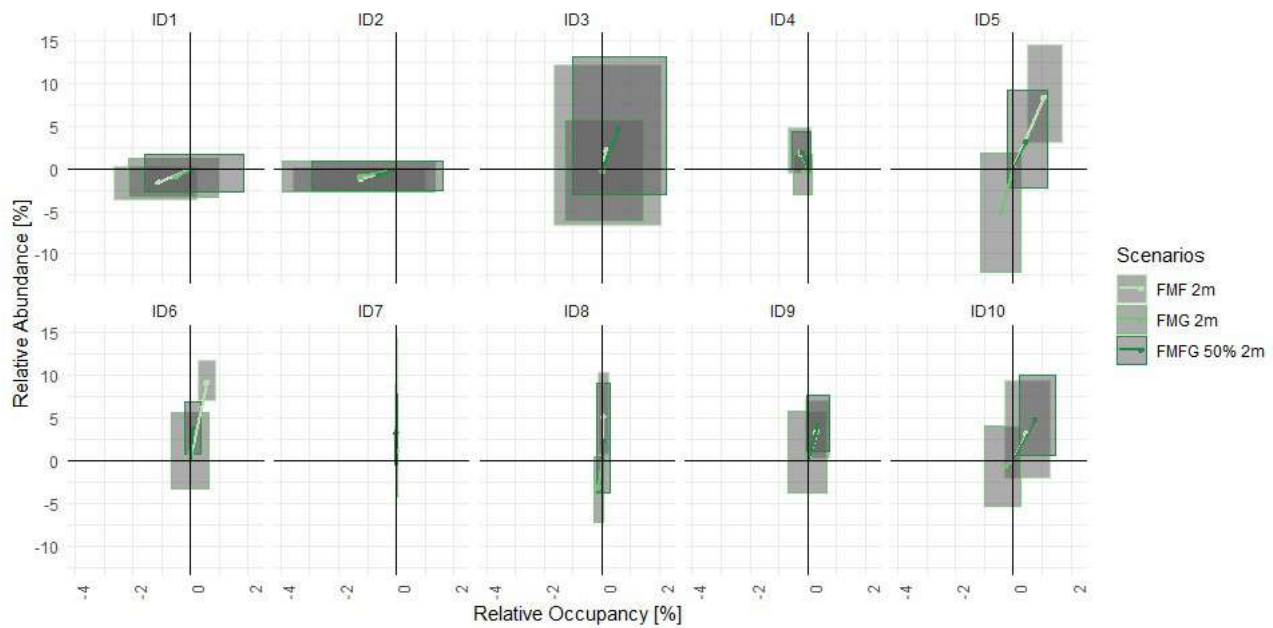


Figure 2.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

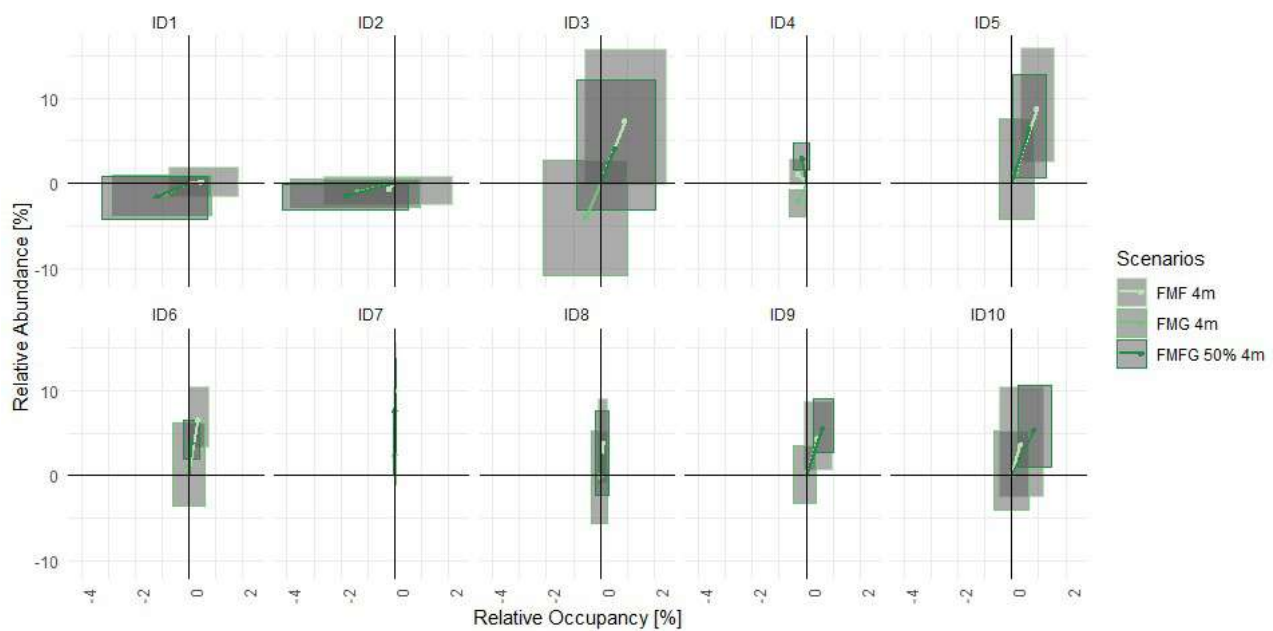


Figure 2.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes..

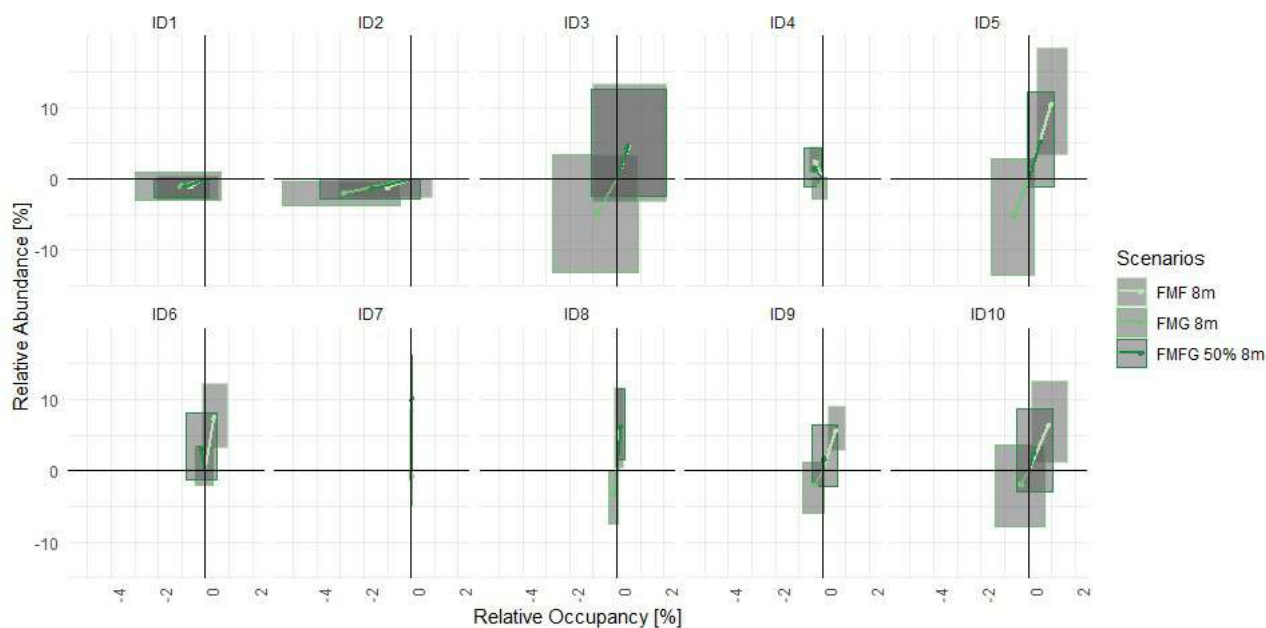


Figure 2.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4.5 Setaside

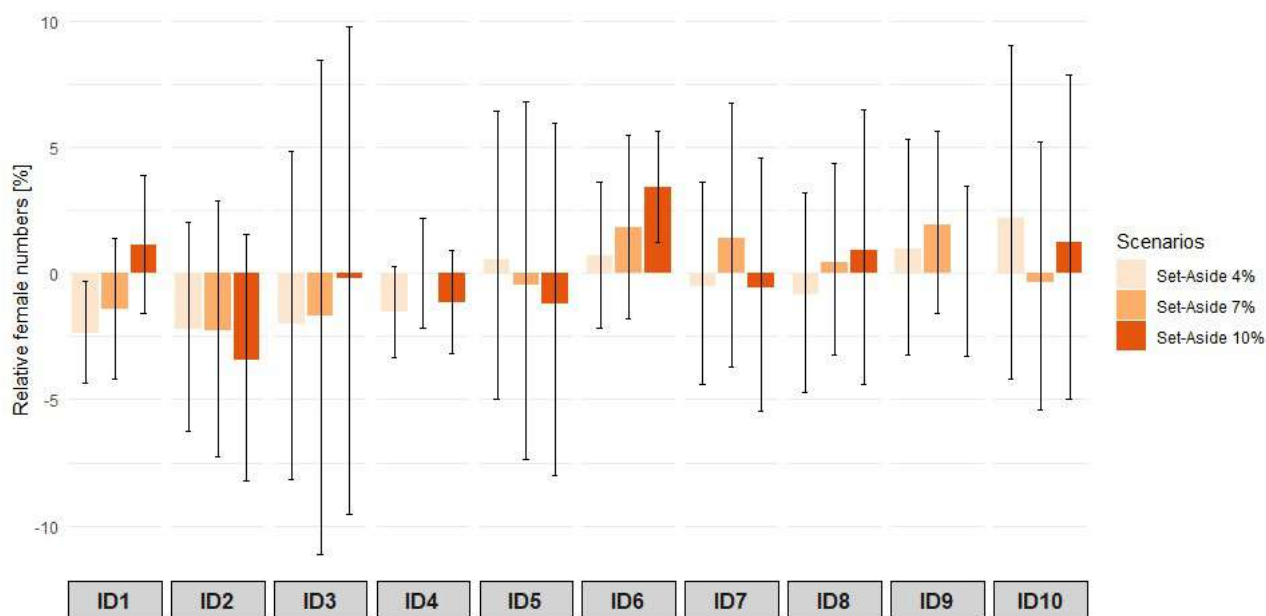


Figure 2.55 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

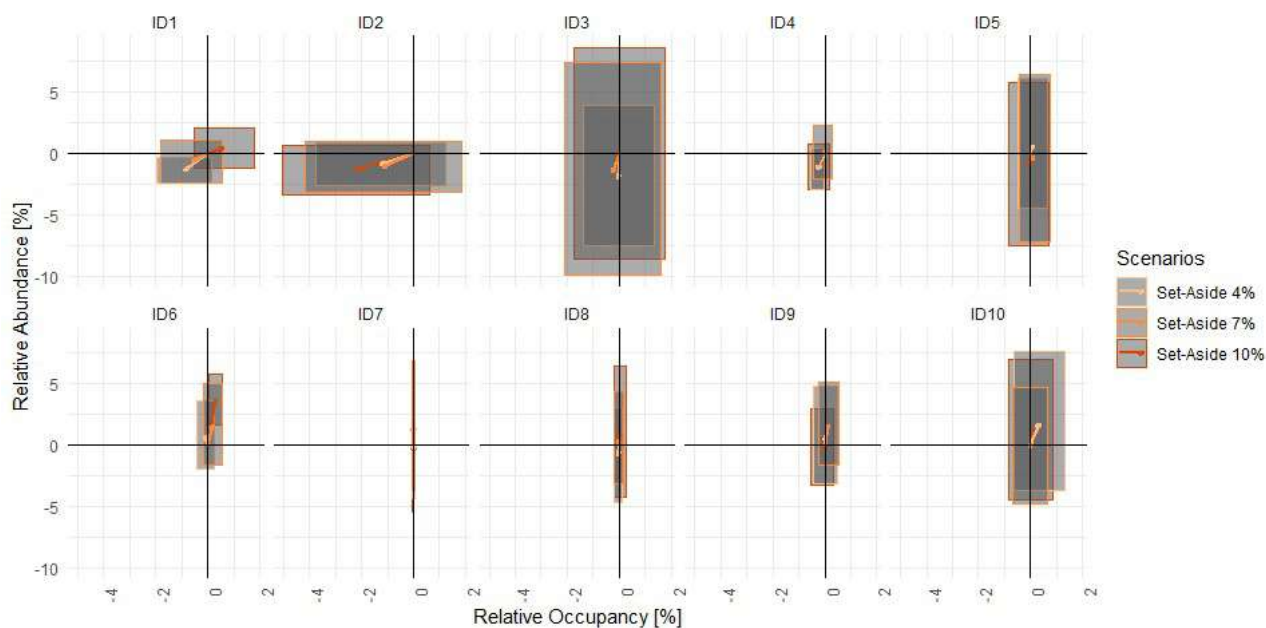


Figure 2.56 Setaside scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4.6 Legume

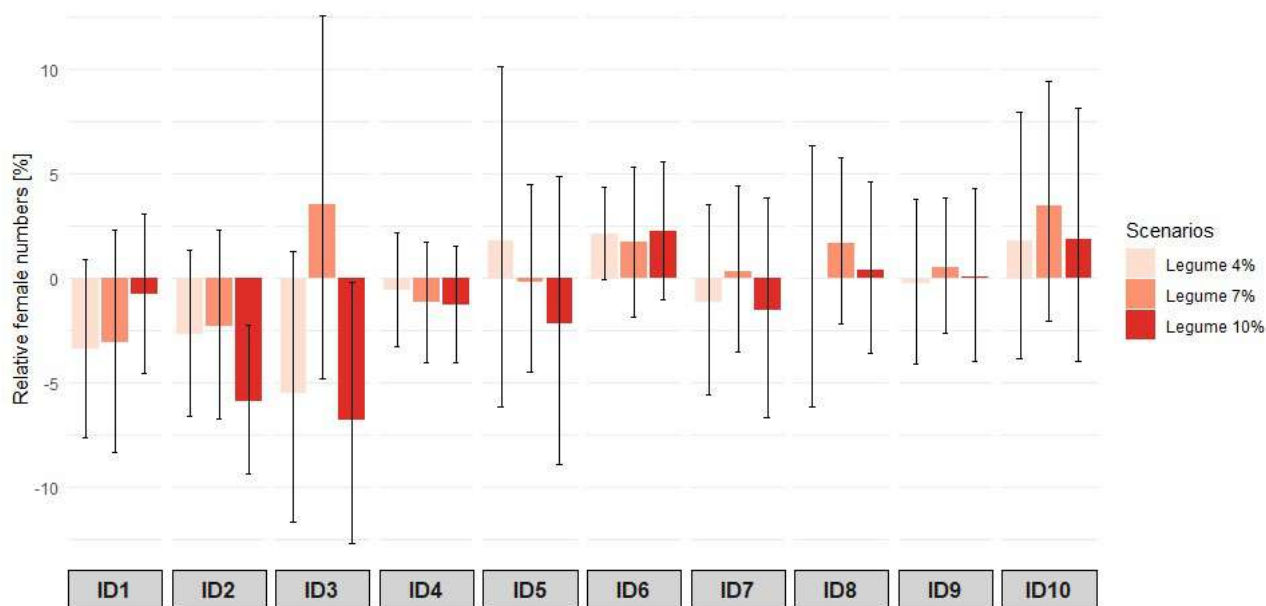


Figure 2.57 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

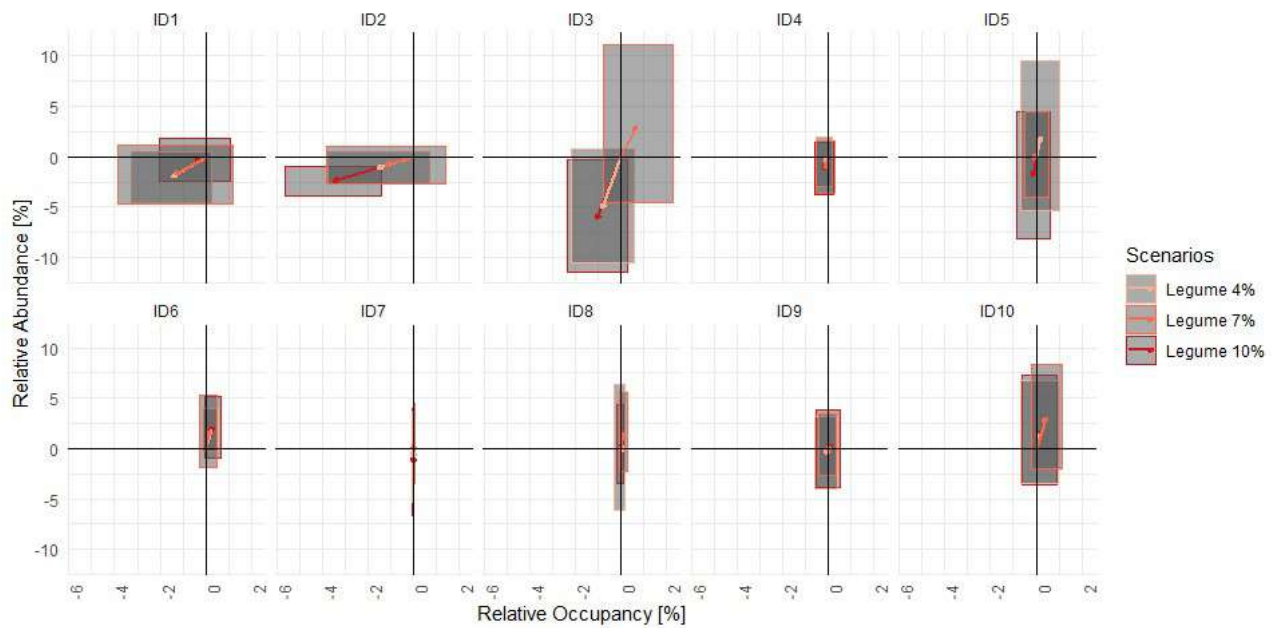


Figure 2.58 Legume scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.4.7 Biopesticides

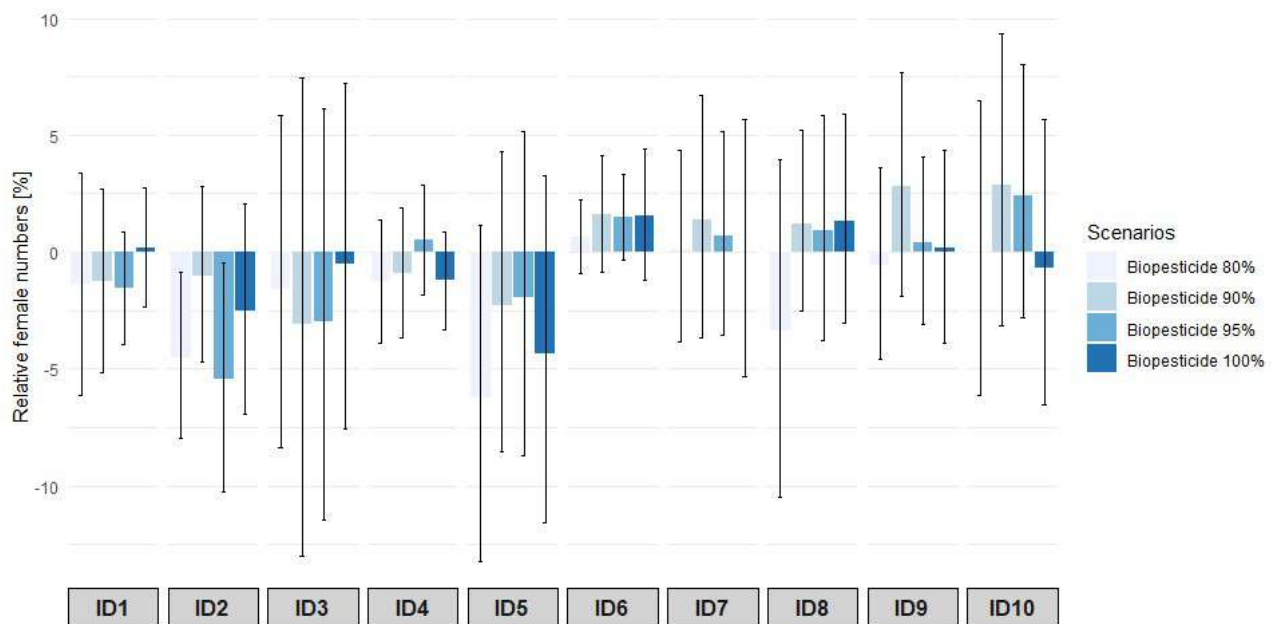


Figure 2.59 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

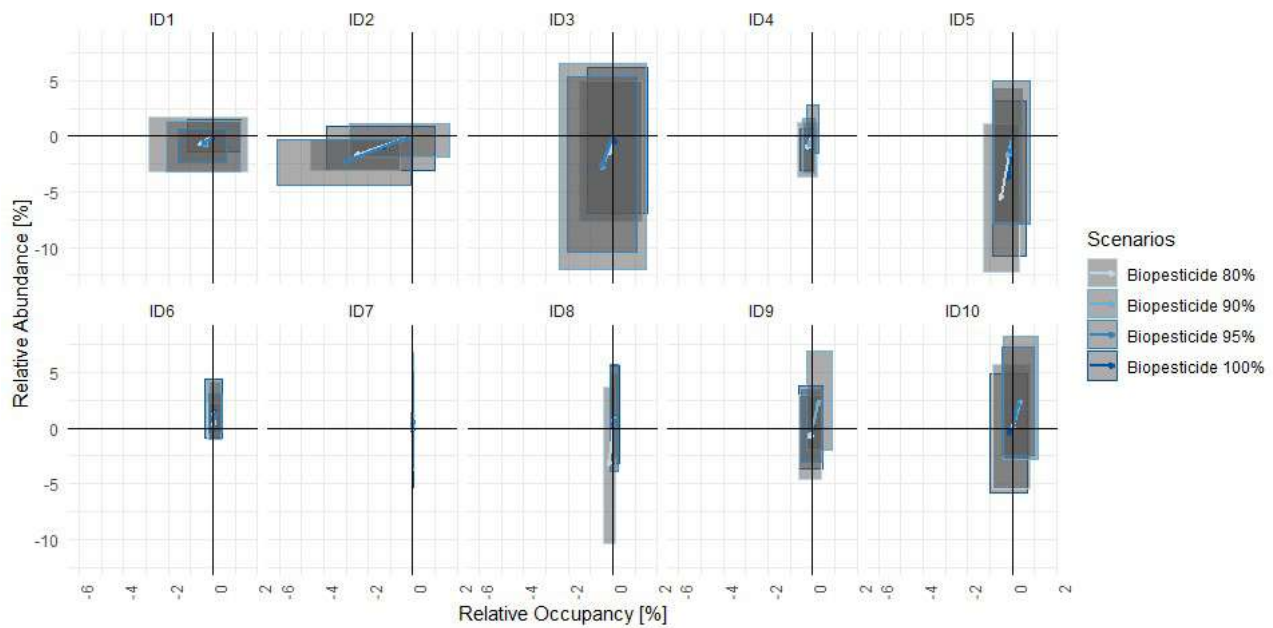


Figure 2.60 Biopesticide scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5 Finland

2.5.1 Flower field margins

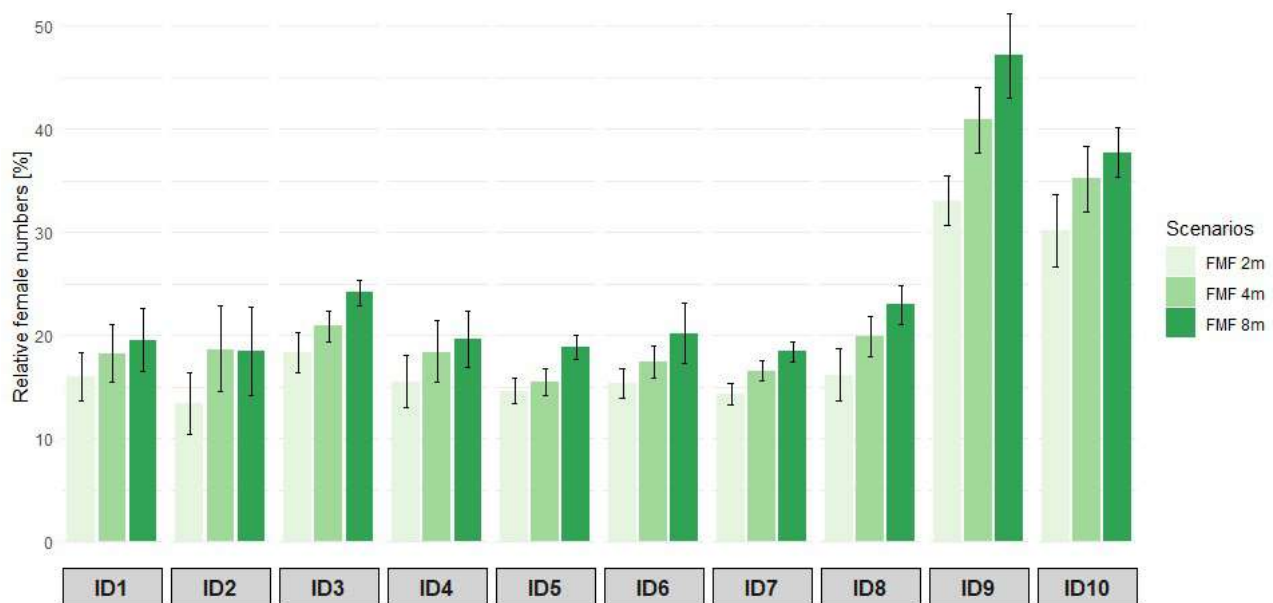


Figure 2.61 Flower field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

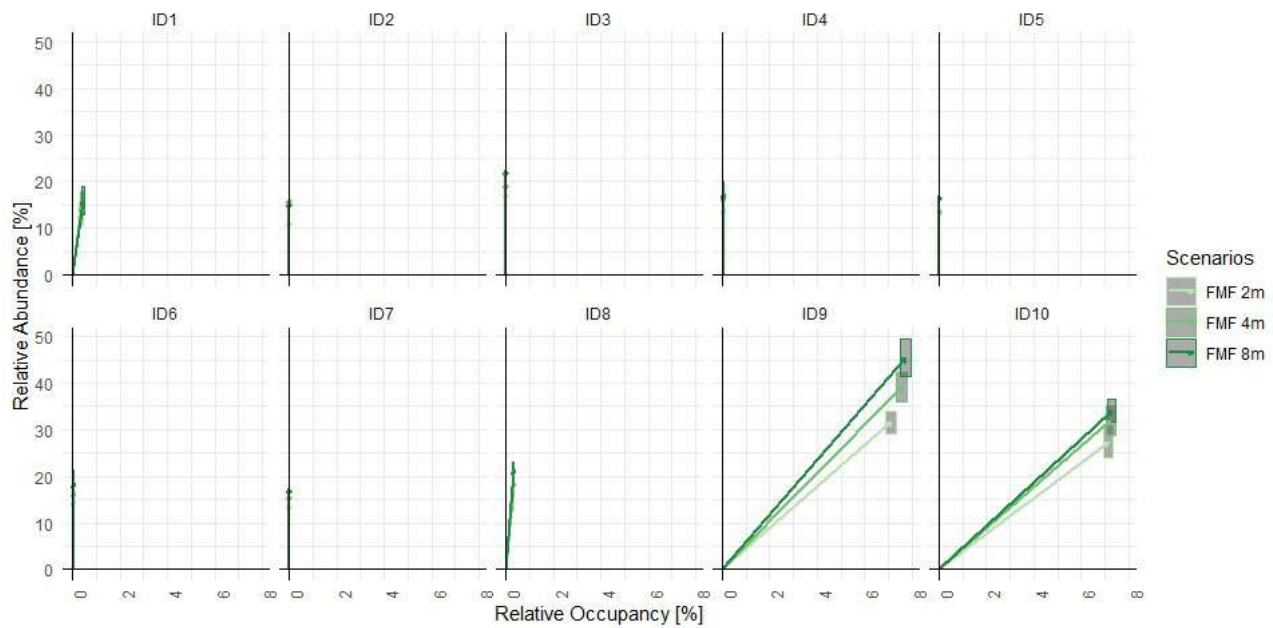


Figure 2.62 Flower field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5.2 Grassy field margins

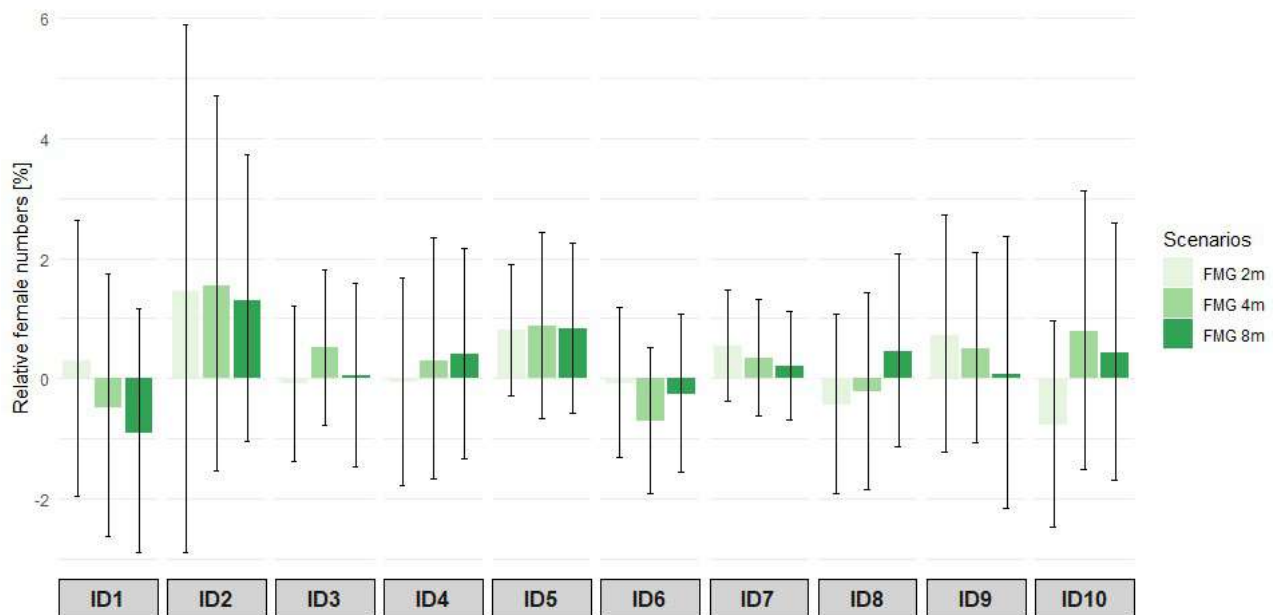


Figure 2.63 Grassy field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

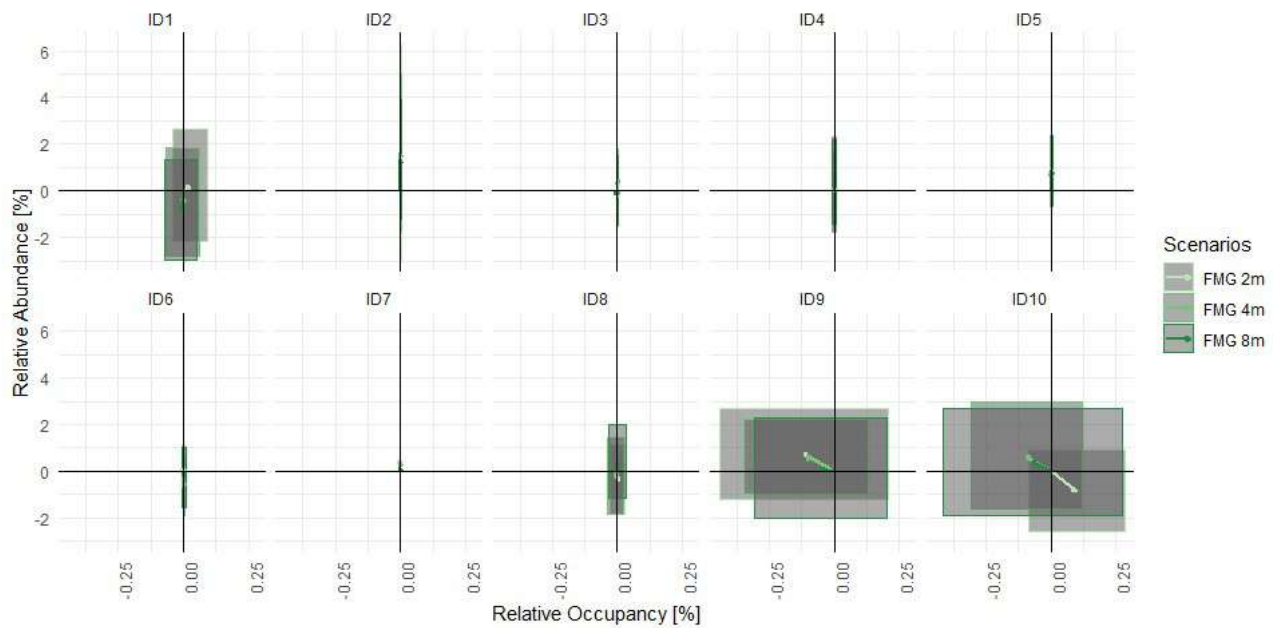


Figure 2.64 Grassy field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5.3 Mixed field margins

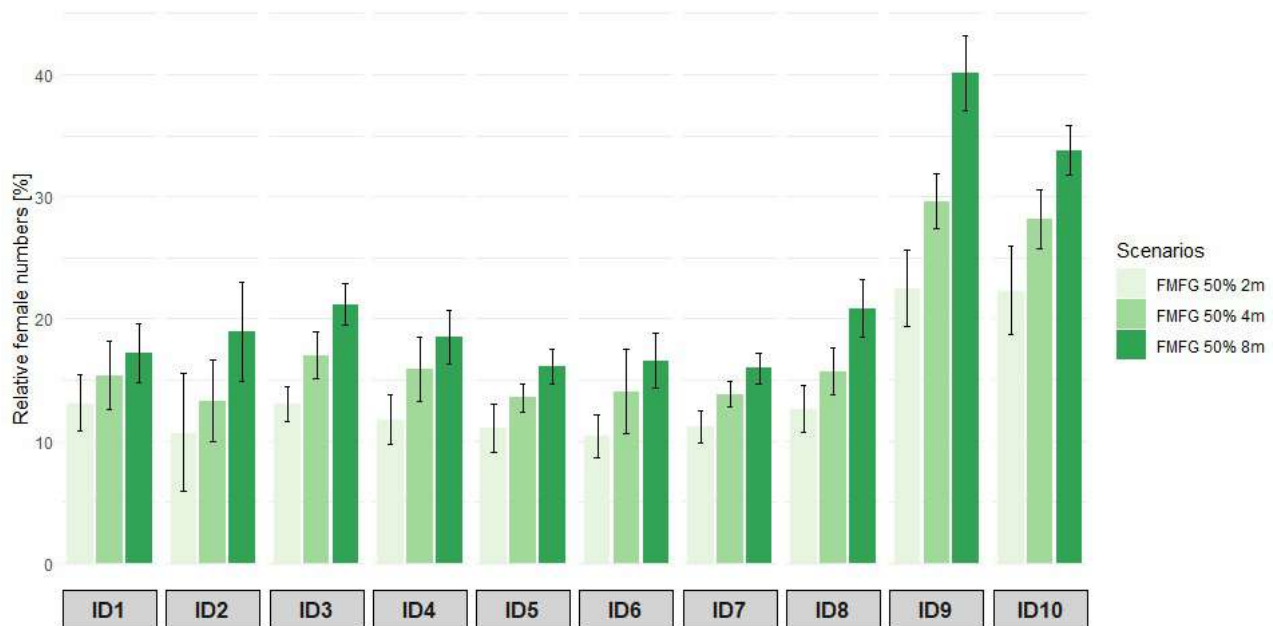


Figure 2.65 Mixed field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

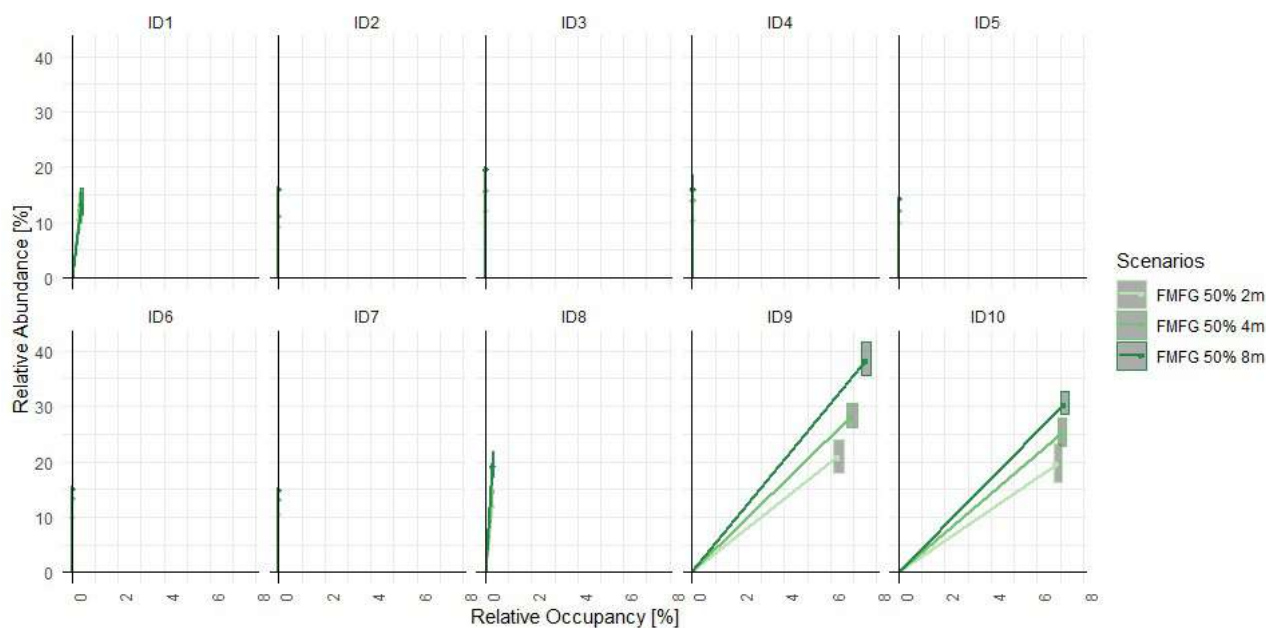


Figure 2.66 Mixed field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5.4 Flower, grassy and mixed field margins

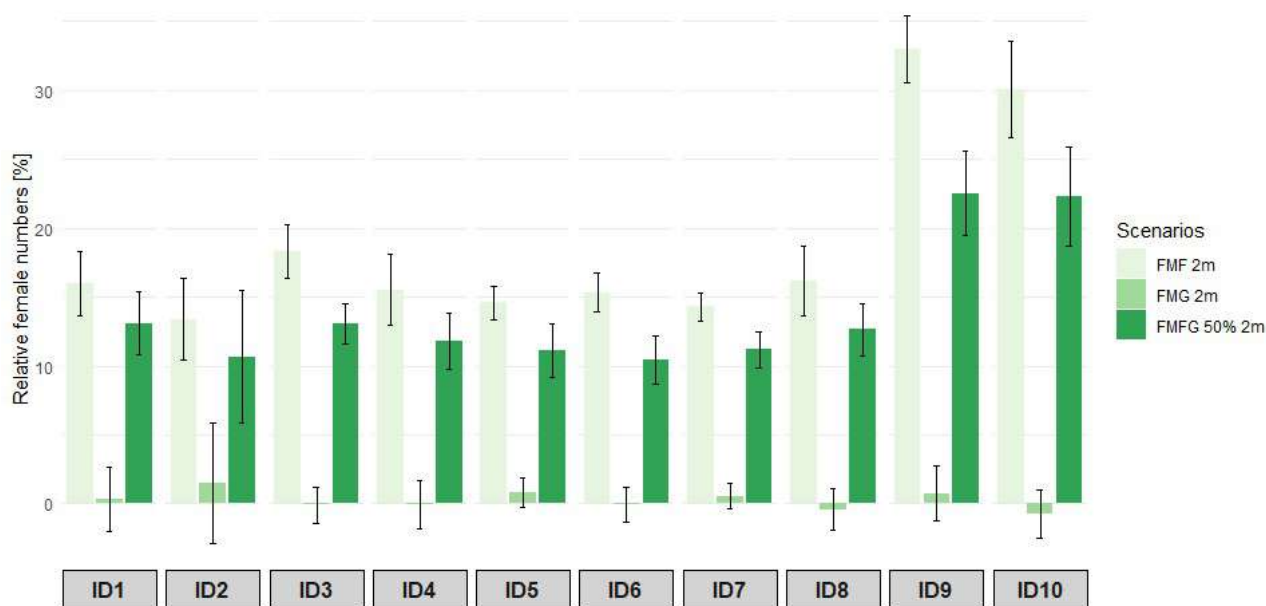


Figure 2.67 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

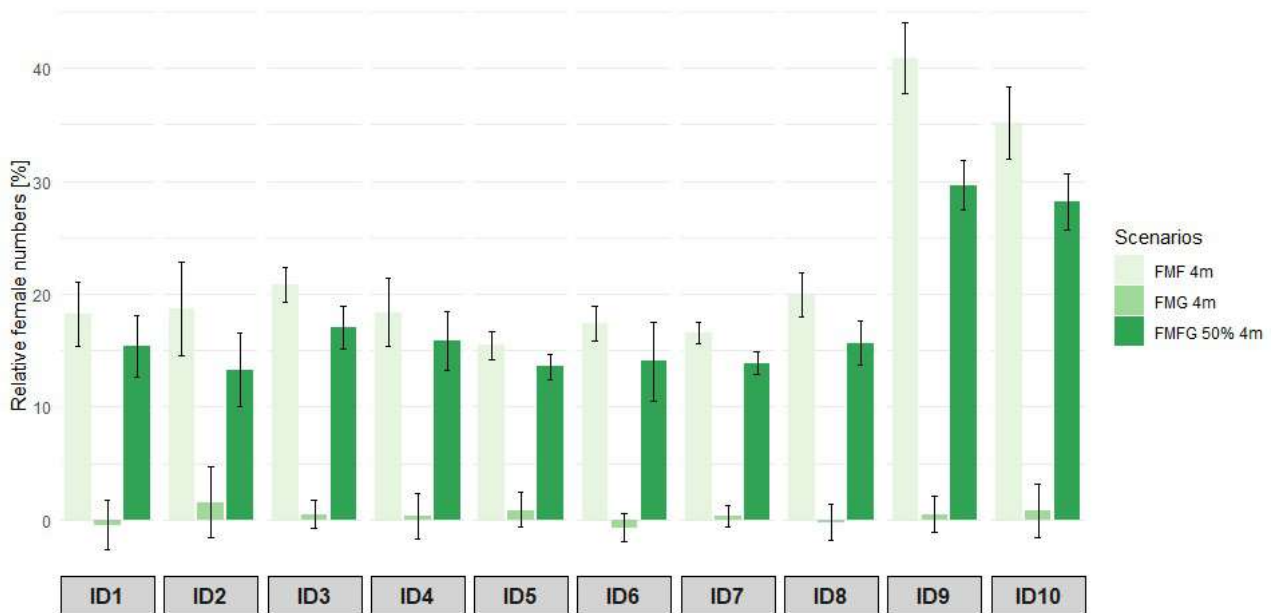


Figure 2.68 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

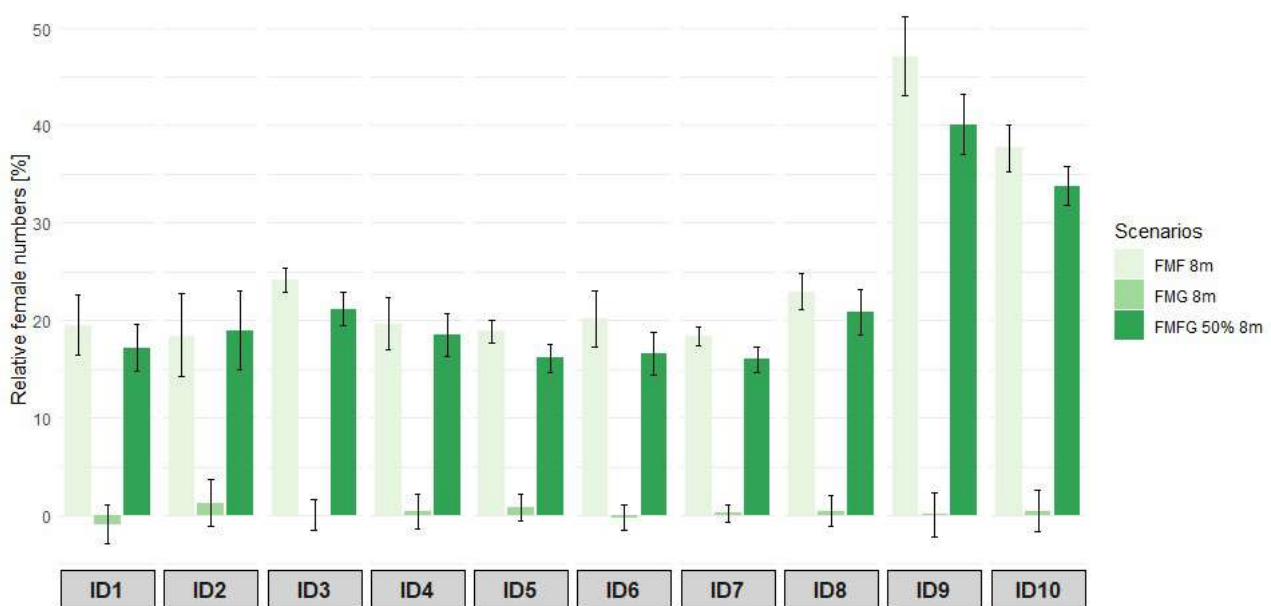


Figure 2.69 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

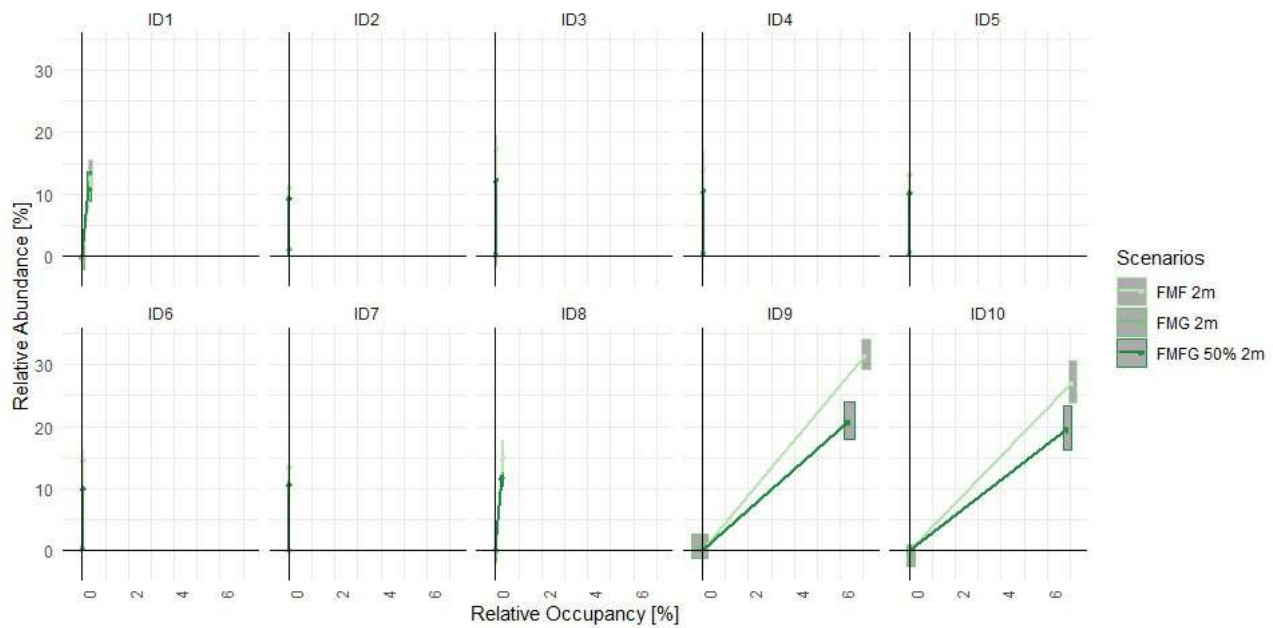


Figure 2.70 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

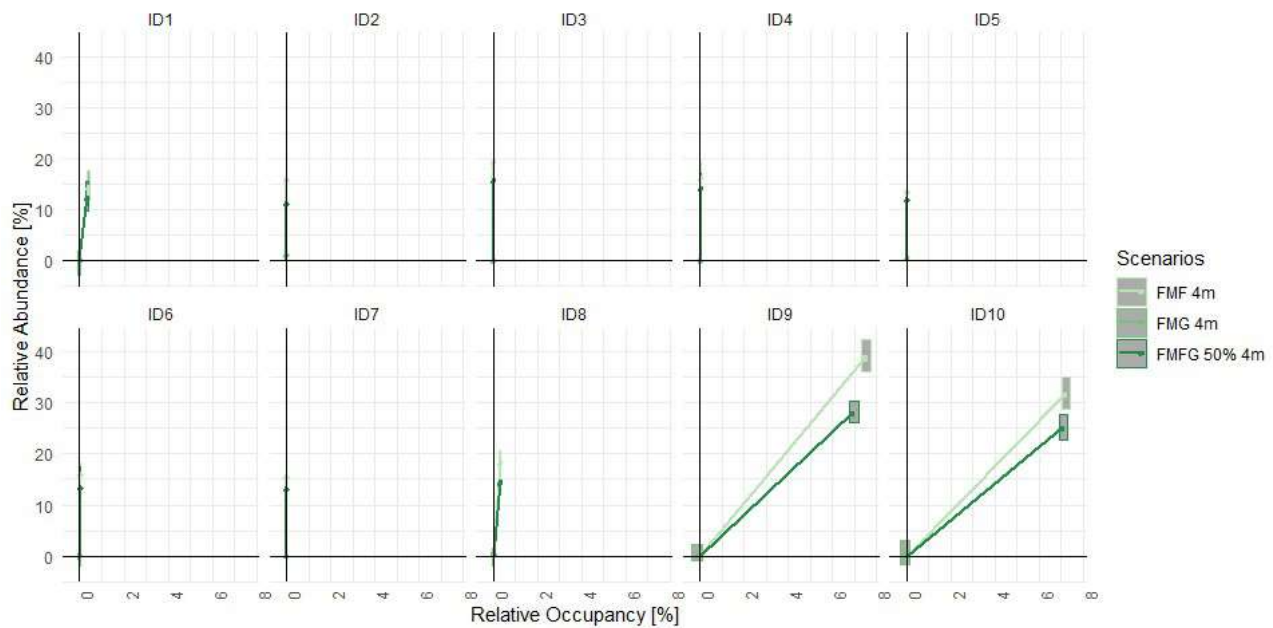


Figure 2.71 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes..

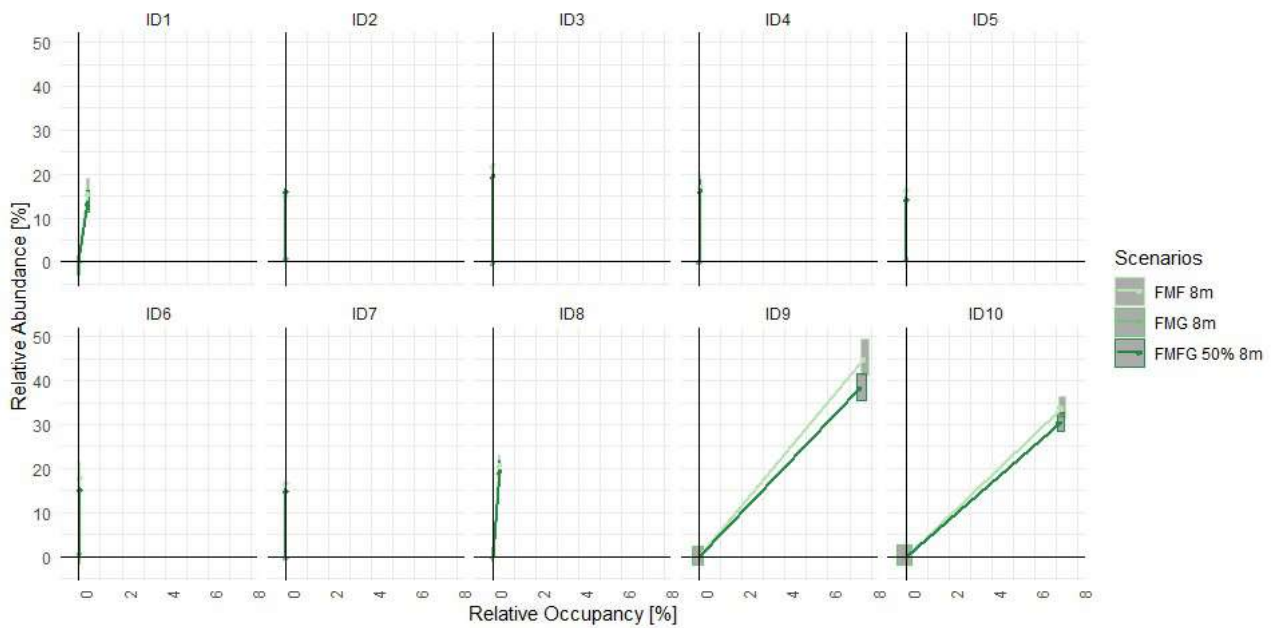


Figure 2.72 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5.5 Setaside

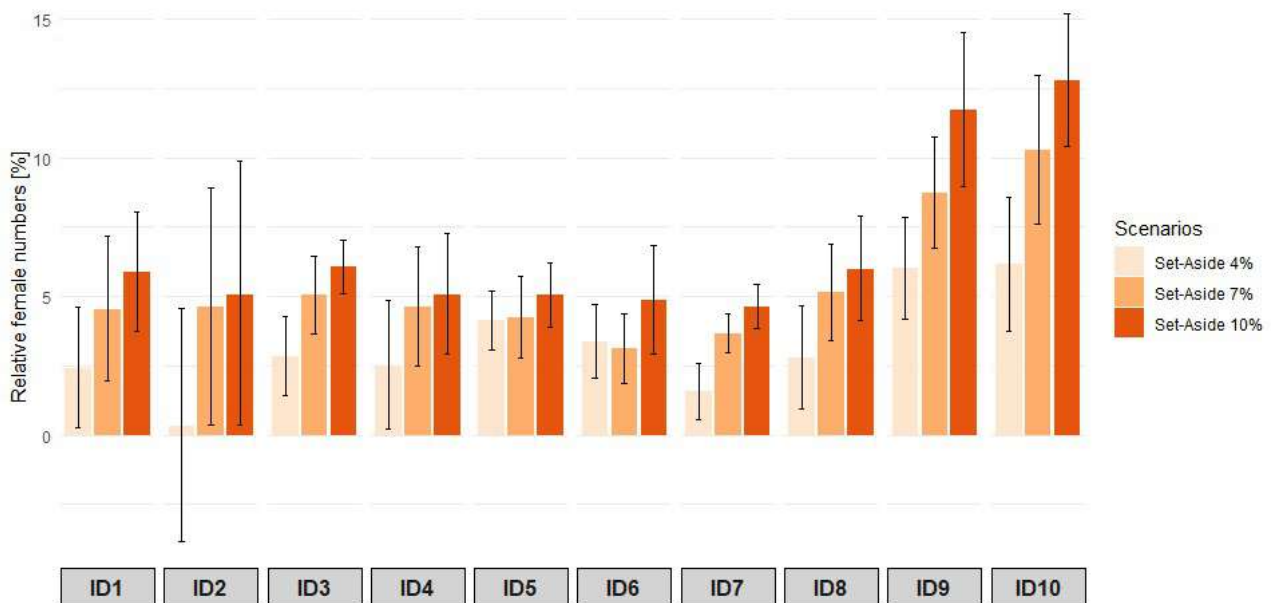


Figure 2.73 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

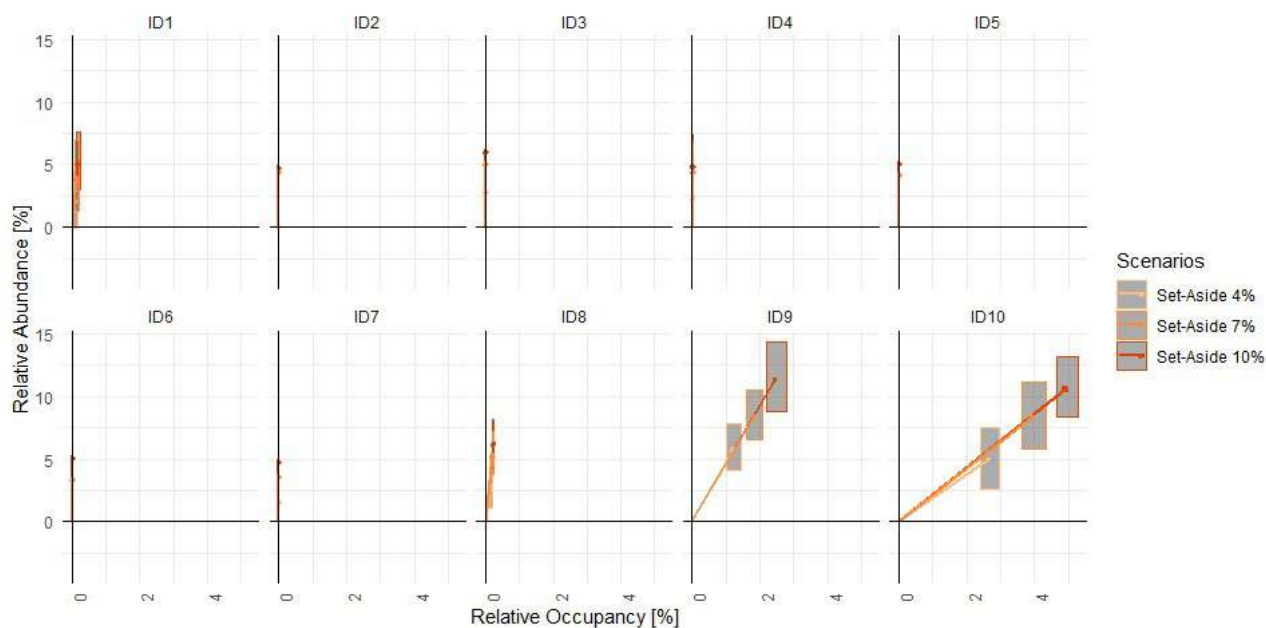


Figure 2.74 Setaside scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5.6 Legume

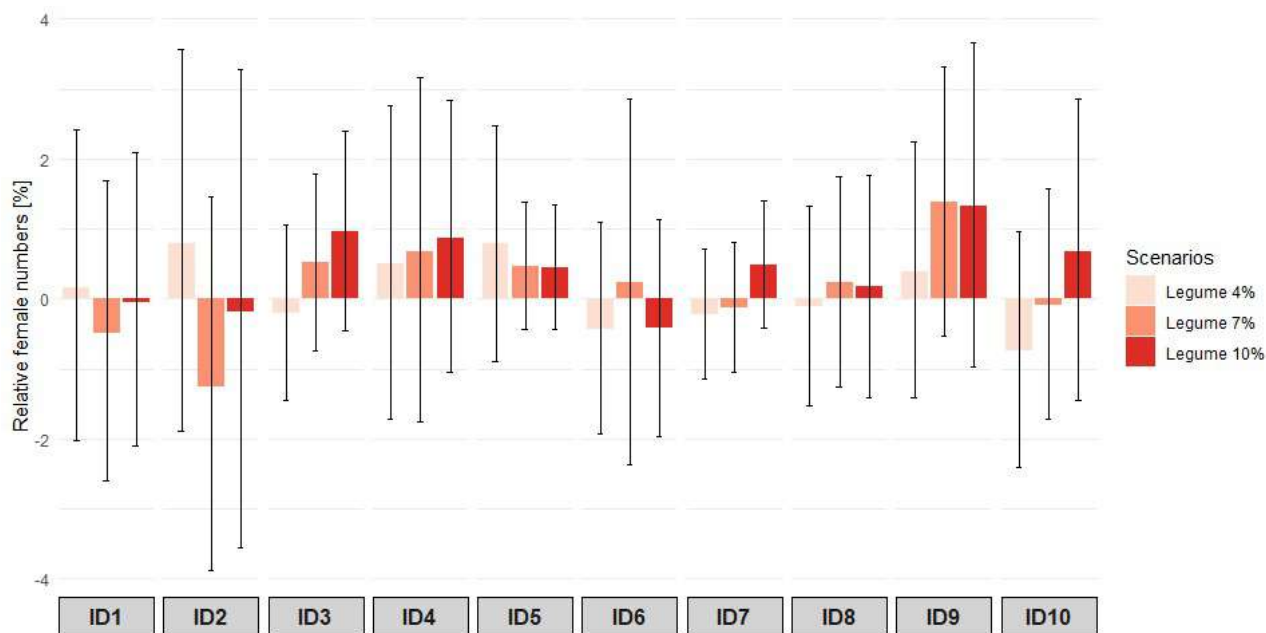


Figure 2.75 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

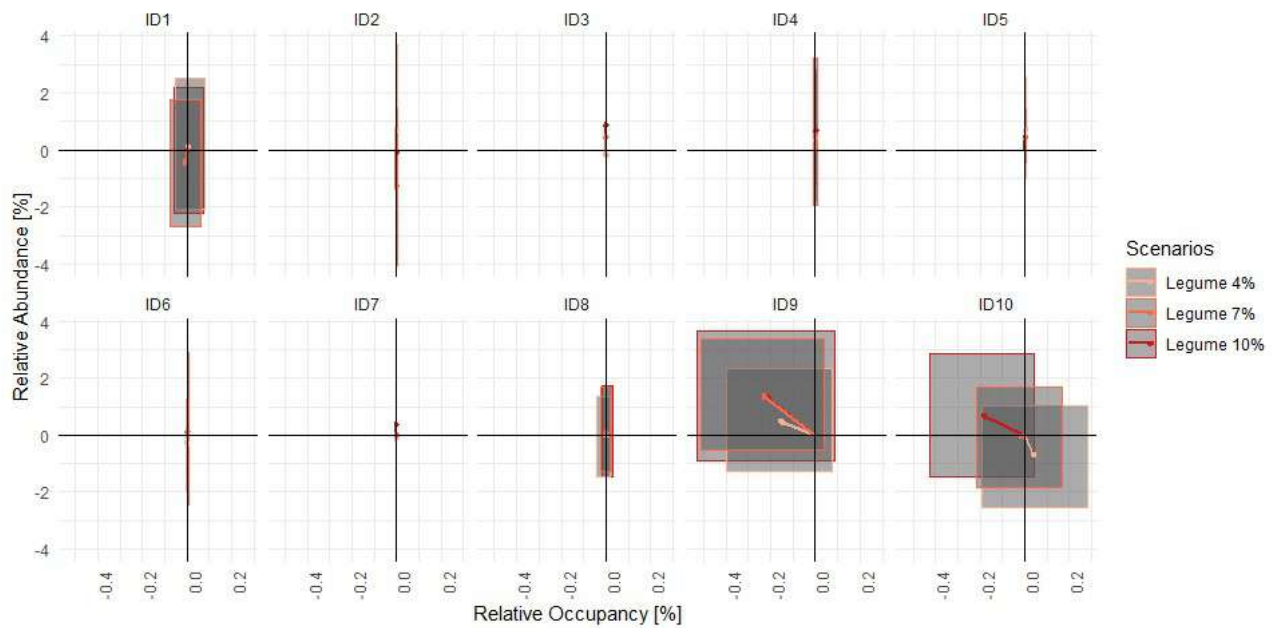


Figure 2.76 Legume scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.5.7 Biopesticides

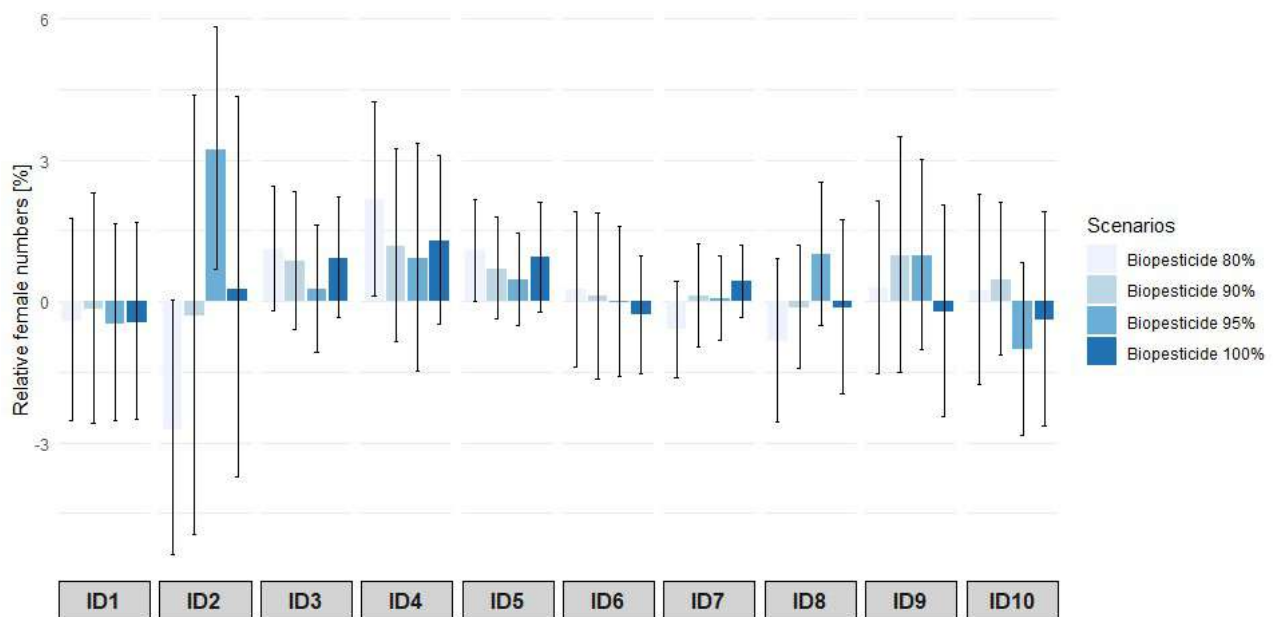


Figure 2.77 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in Finland.

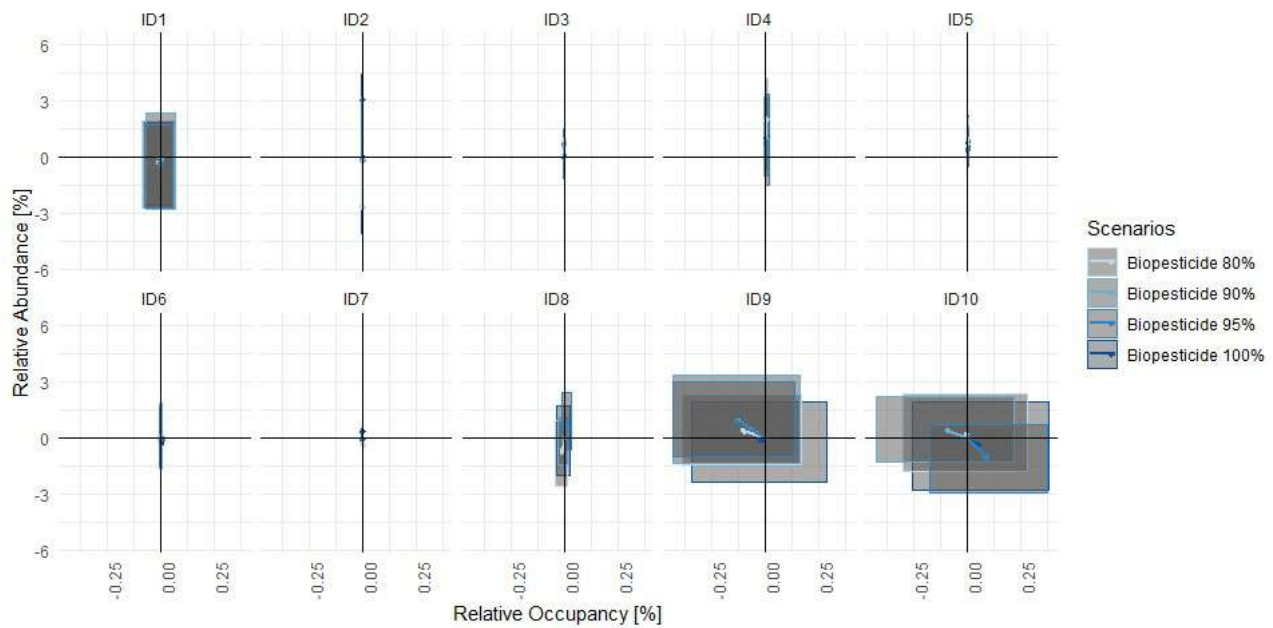


Figure 2.78 Biopesticide scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in Finland at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6 France

2.6.1 Flower field margins

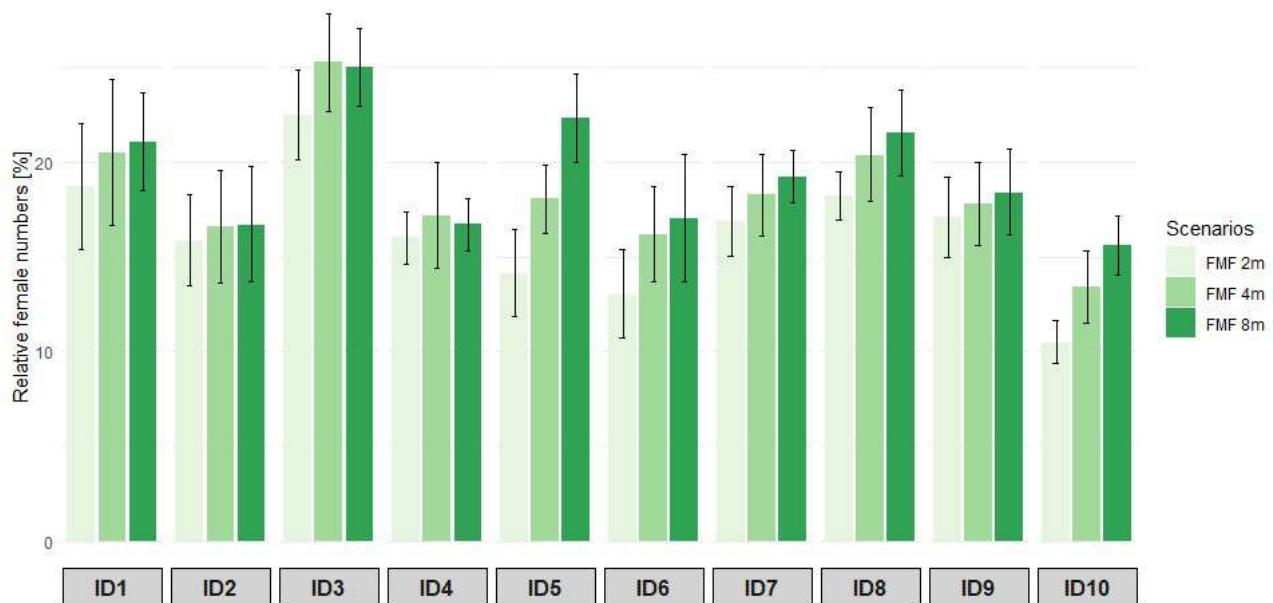


Figure 2.79 Flower field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

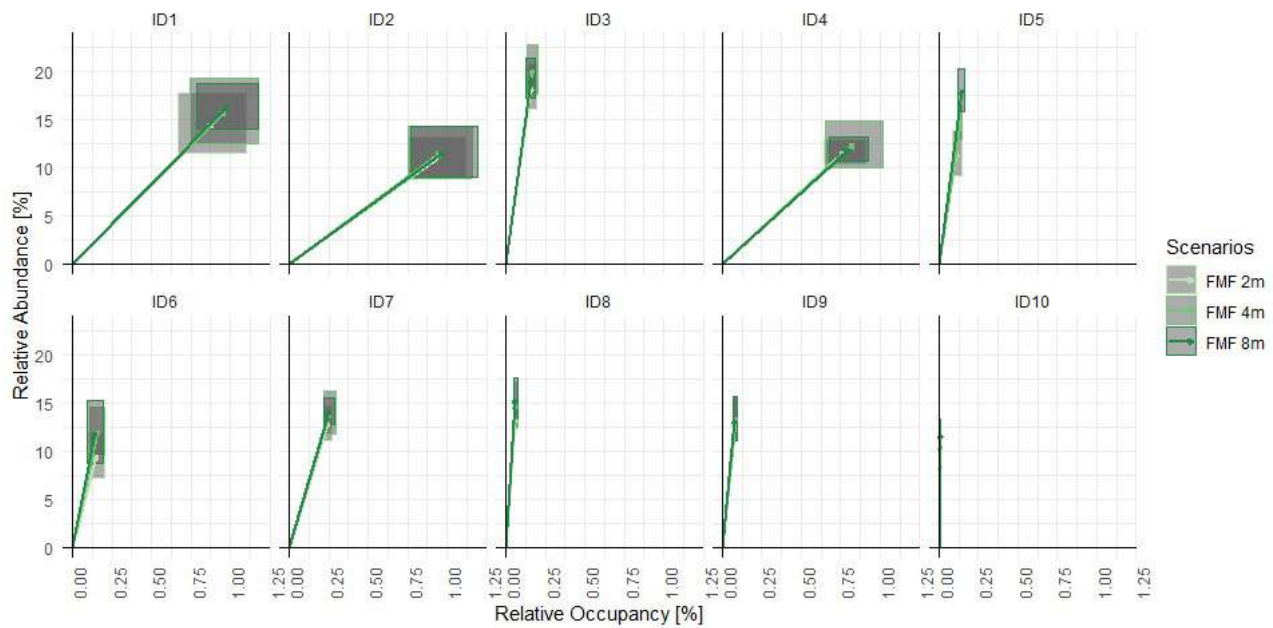


Figure 2.80 Flower field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6.2 Grassy field margins

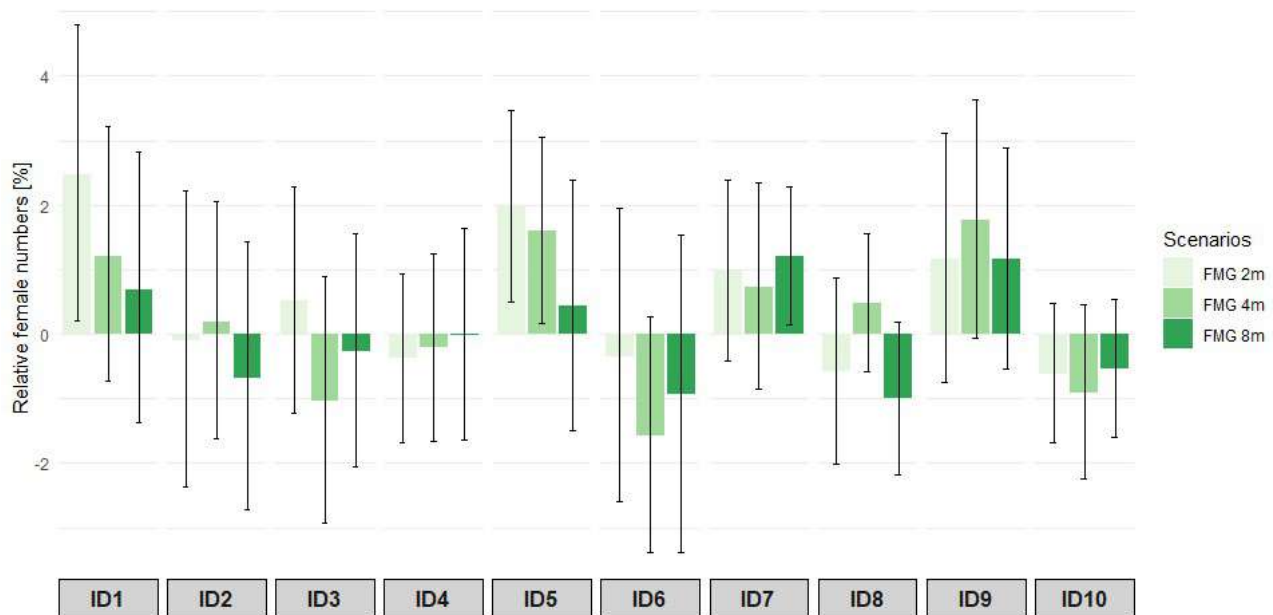


Figure 2.81 Grassy field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

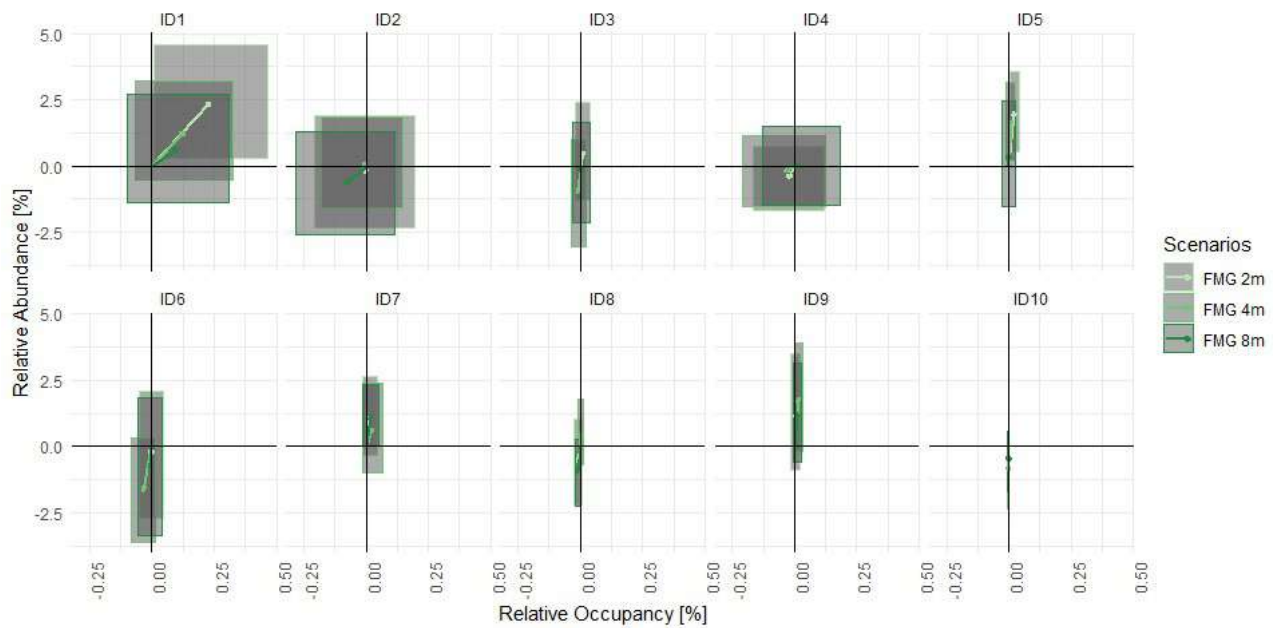


Figure 2.82 Grassy field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6.3 Mixed field margins

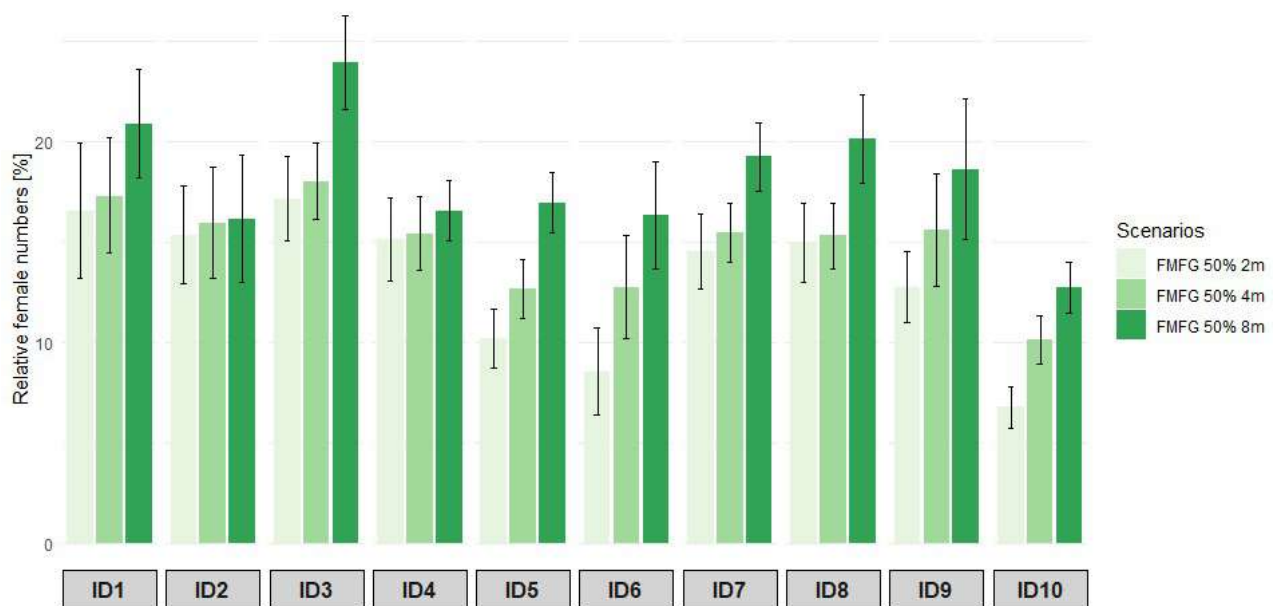


Figure 2.83 Mixed field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

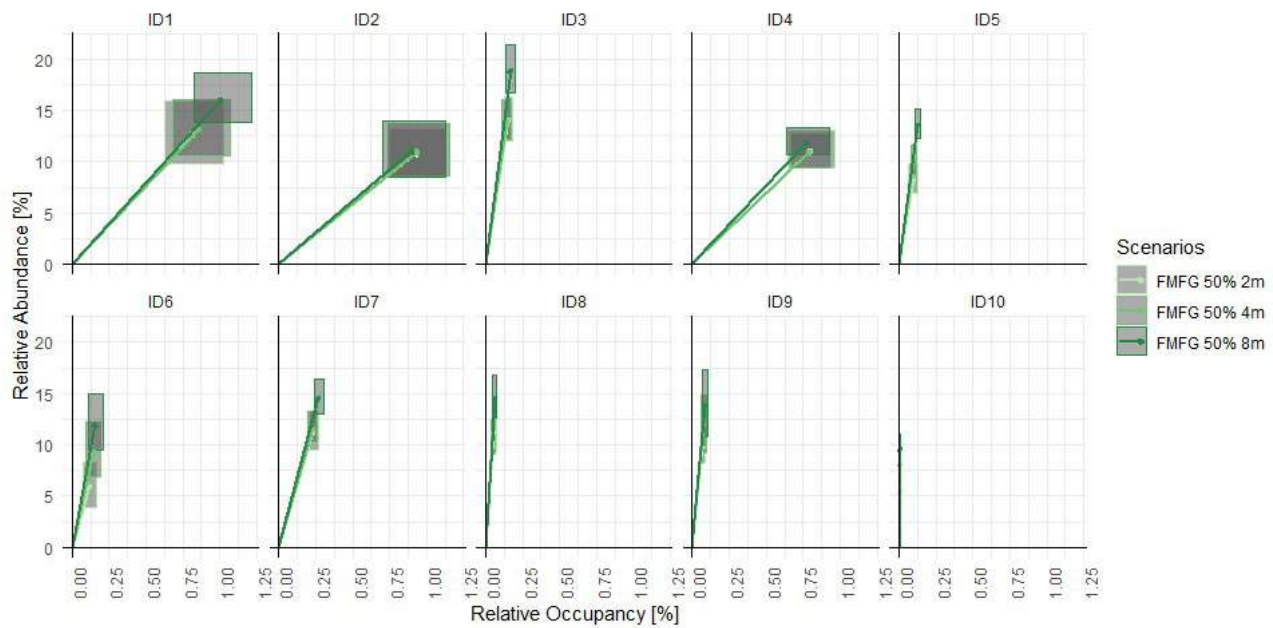


Figure 2.84 Mixed field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6.4 Flower, grassy and mixed field margins

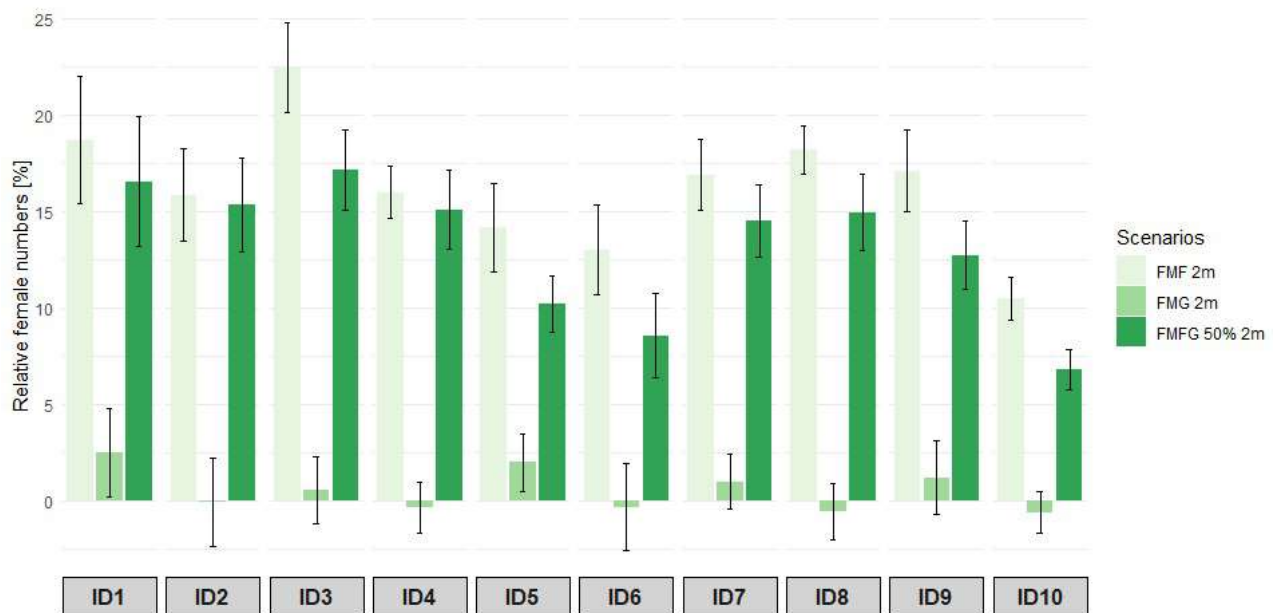


Figure 2.85 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

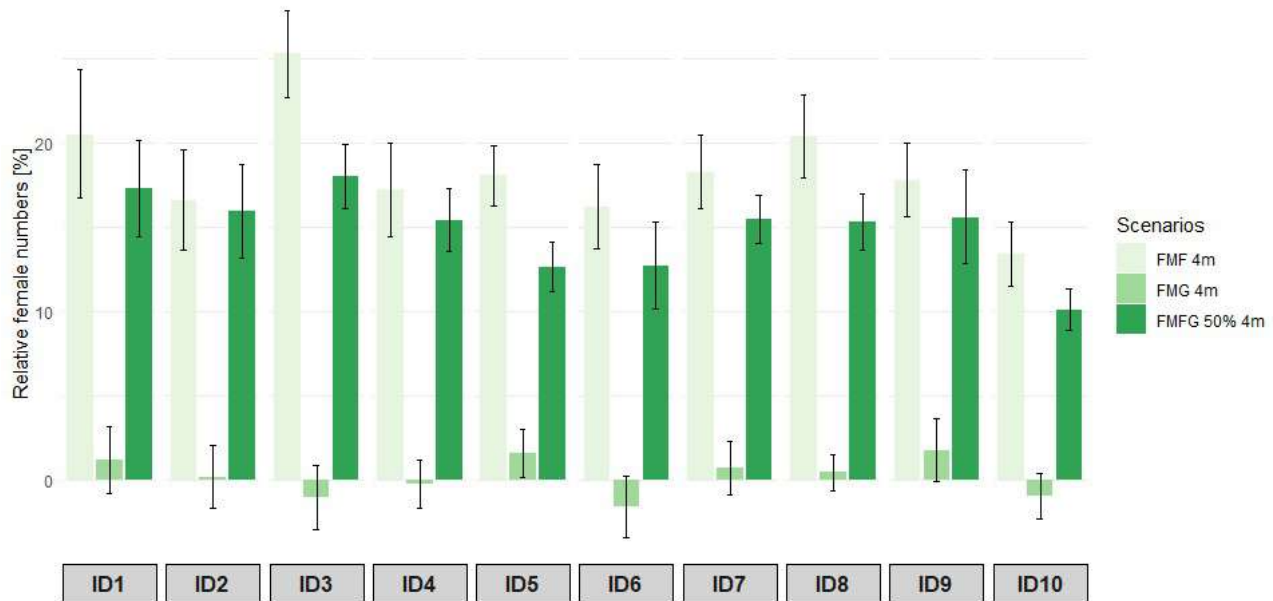


Figure 2.86 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

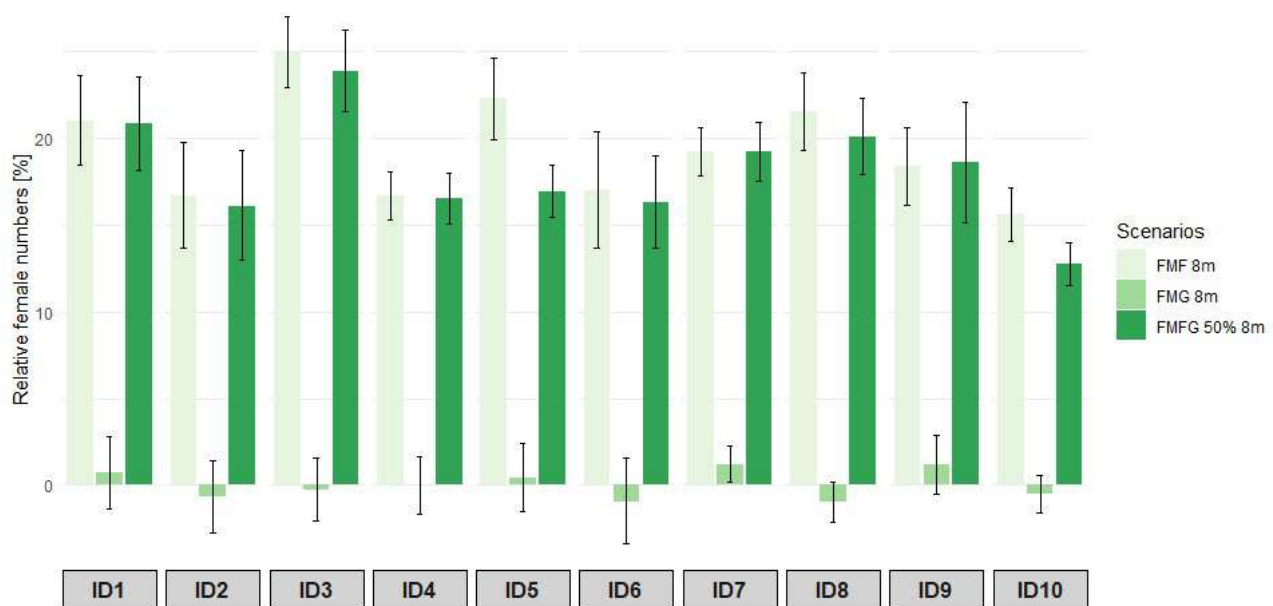


Figure 2.87 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

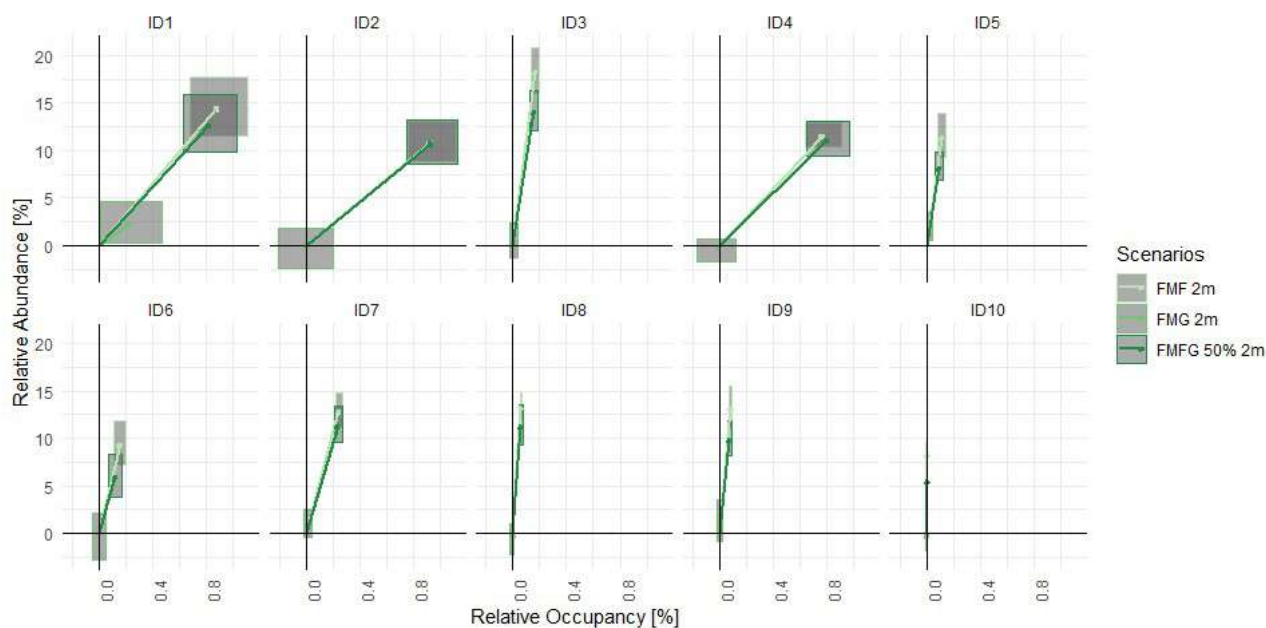


Figure 2.88 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

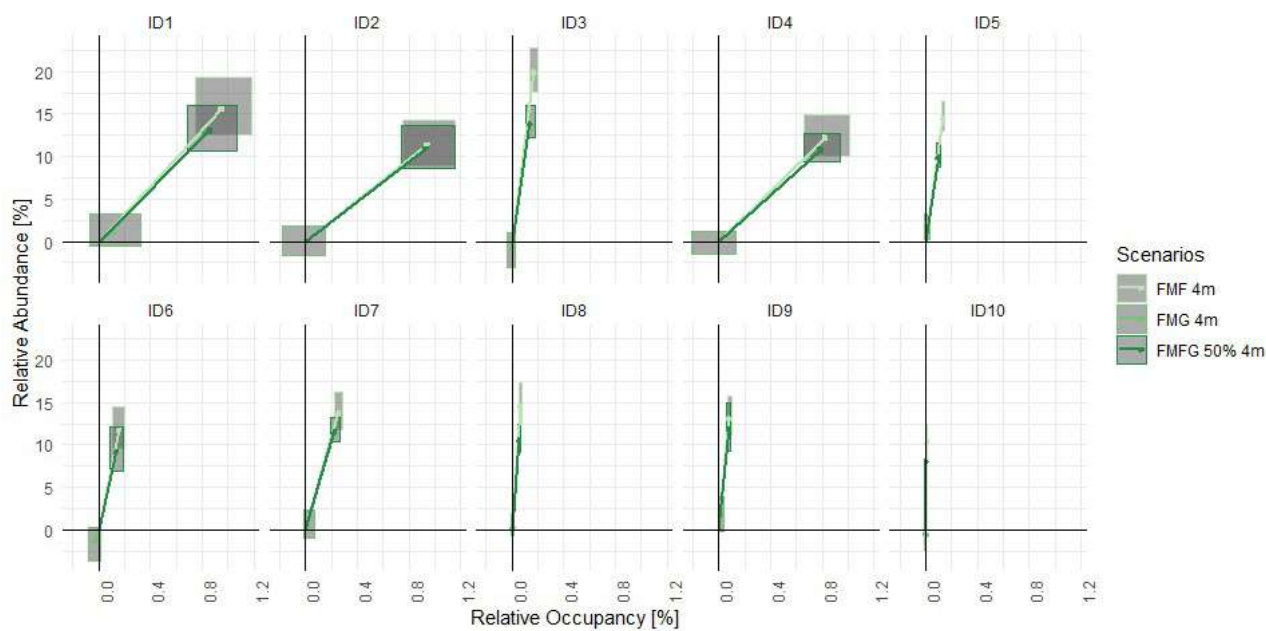


Figure 2.89 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes..

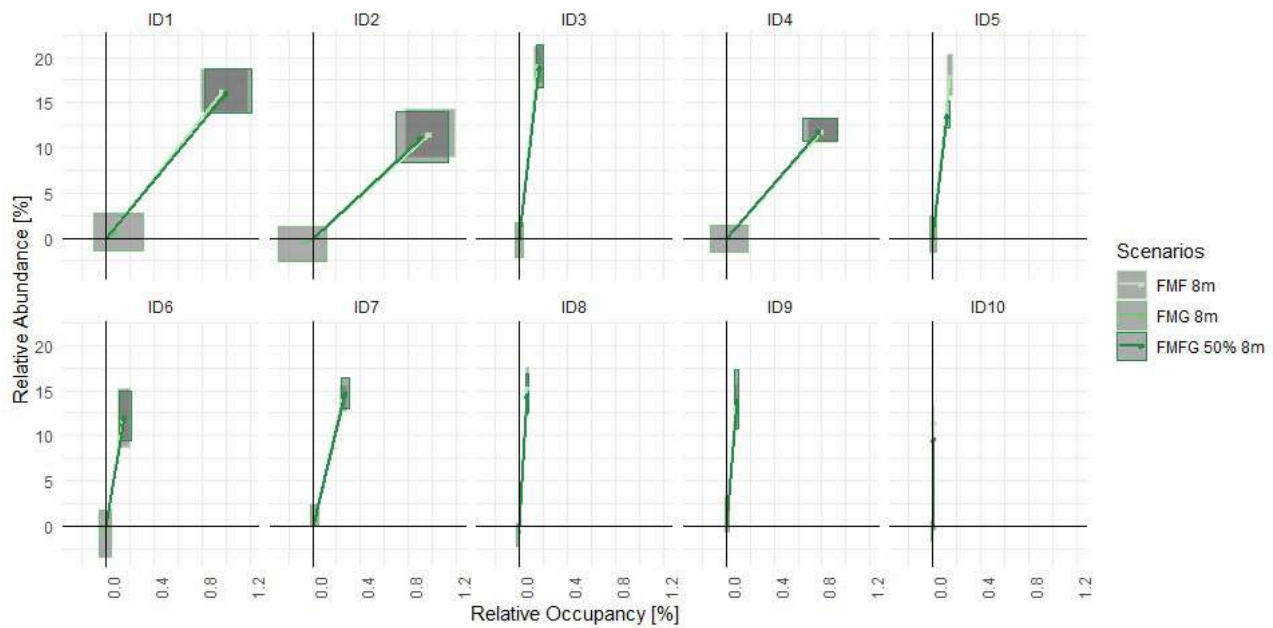


Figure 2.90 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6.5 Setaside

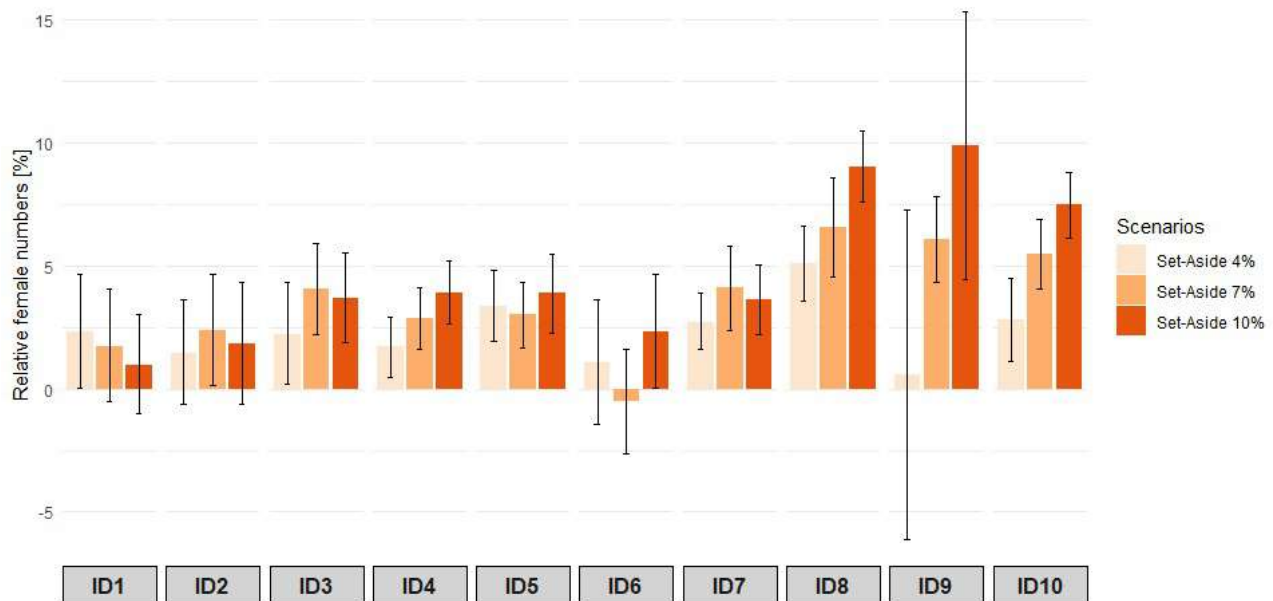


Figure 2.91 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

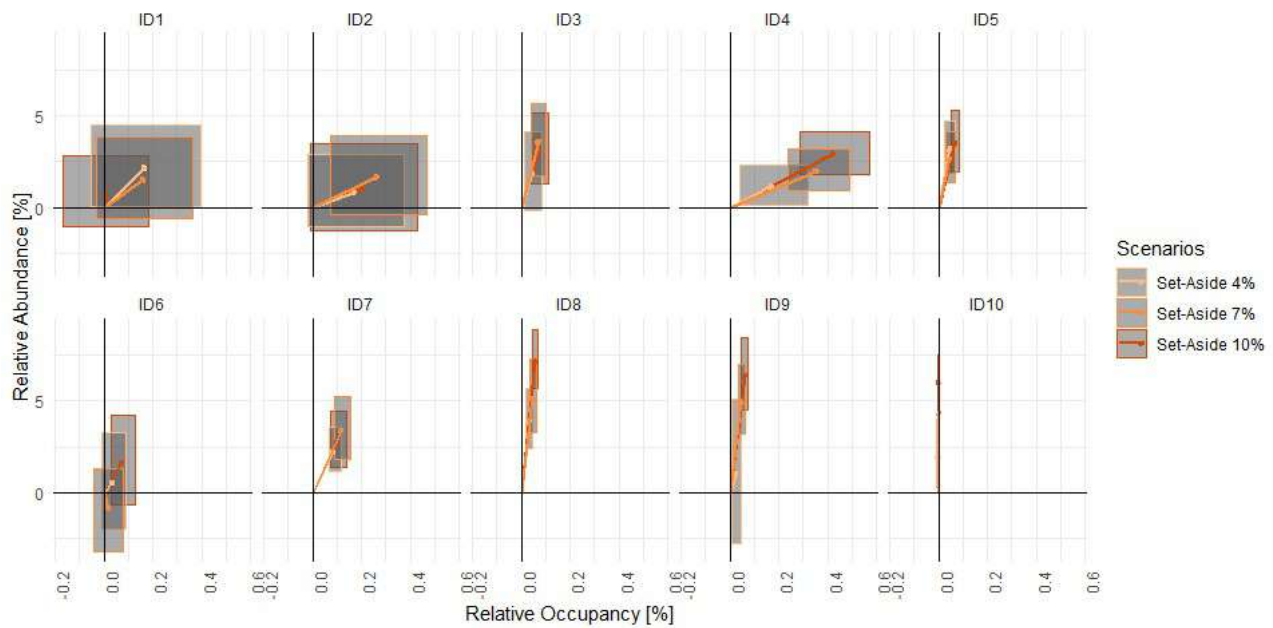


Figure 2.92 Setaside scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6.6 Legume

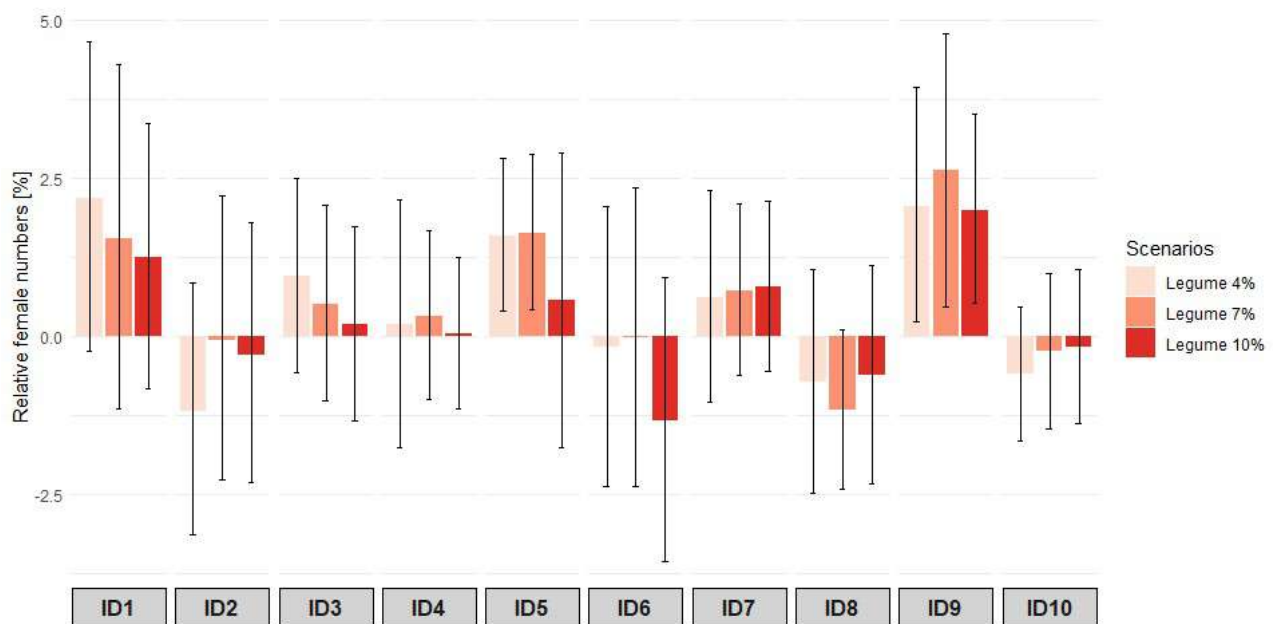


Figure 2.93 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

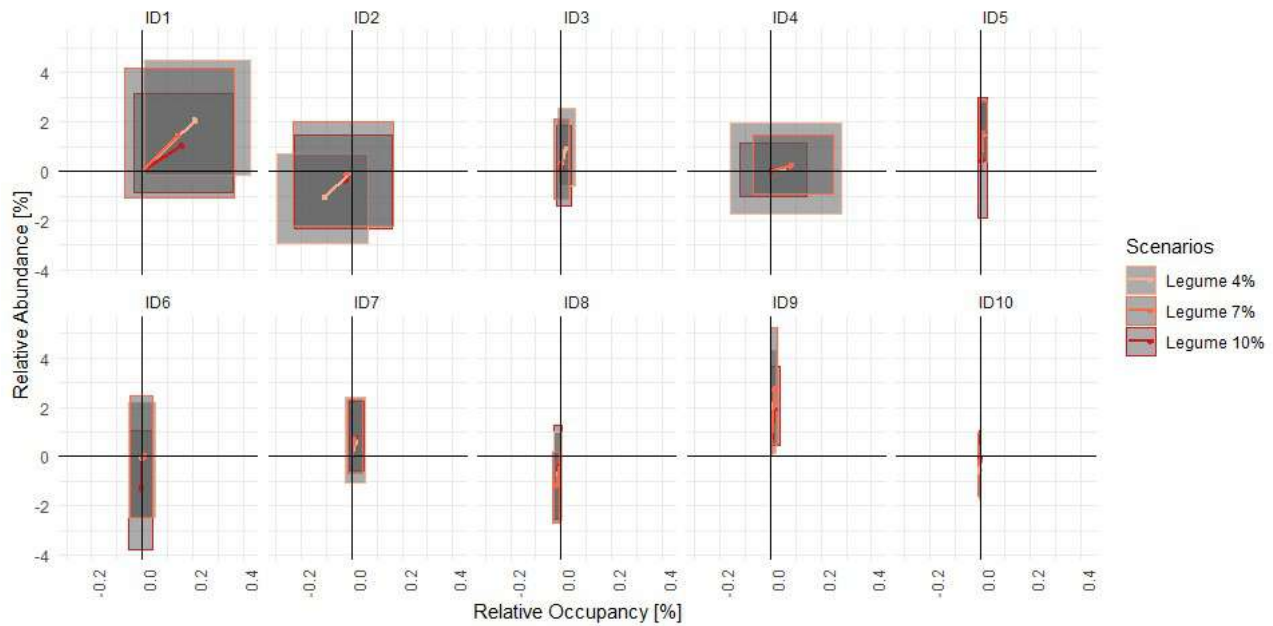


Figure 2.94 Legume scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.6.7 Biopesticides

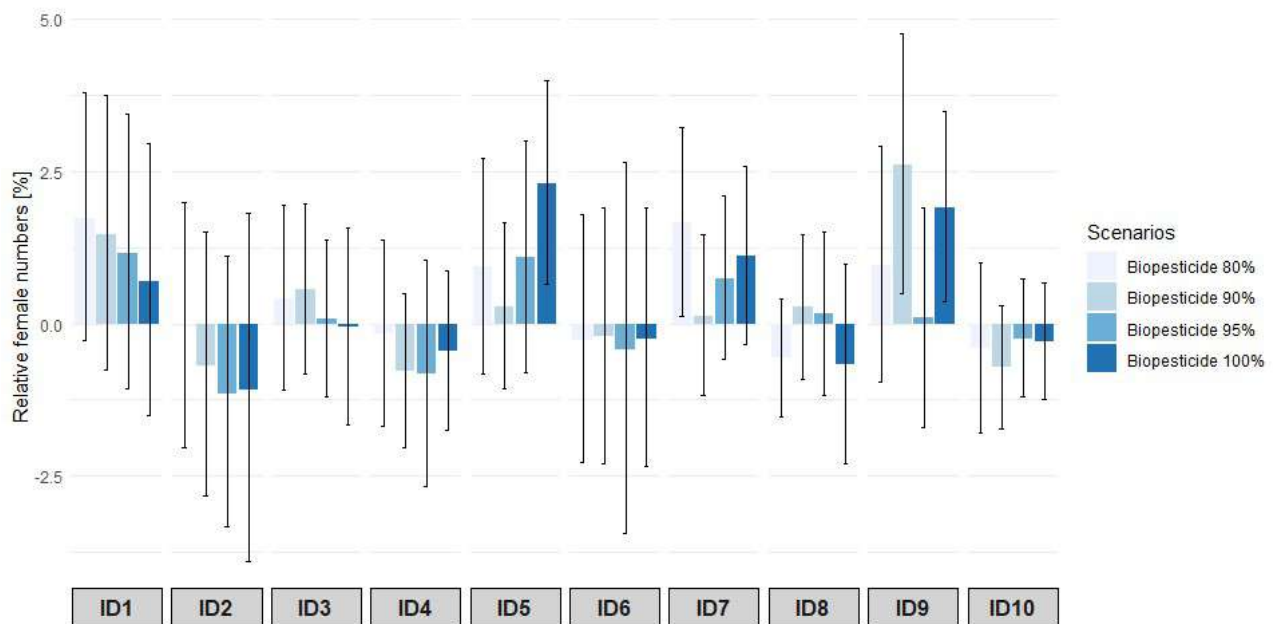


Figure 2.95 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in France.

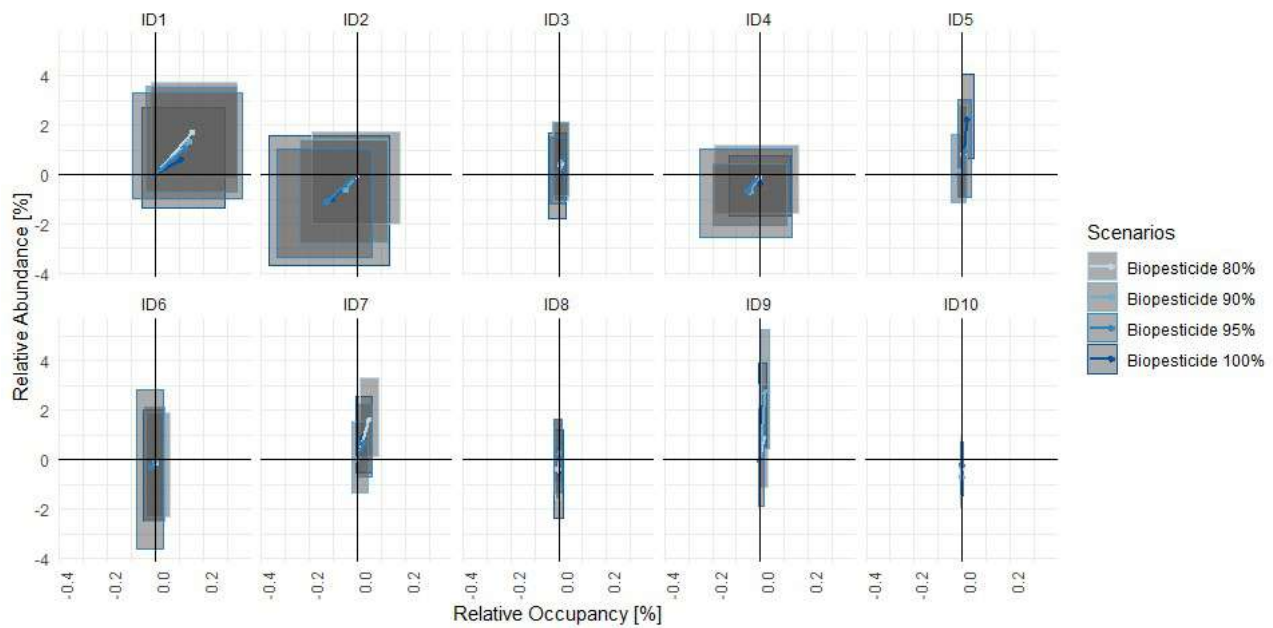


Figure 2.96 Biopesticide scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in France at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7 Netherlands

2.7.1 Flower field margins

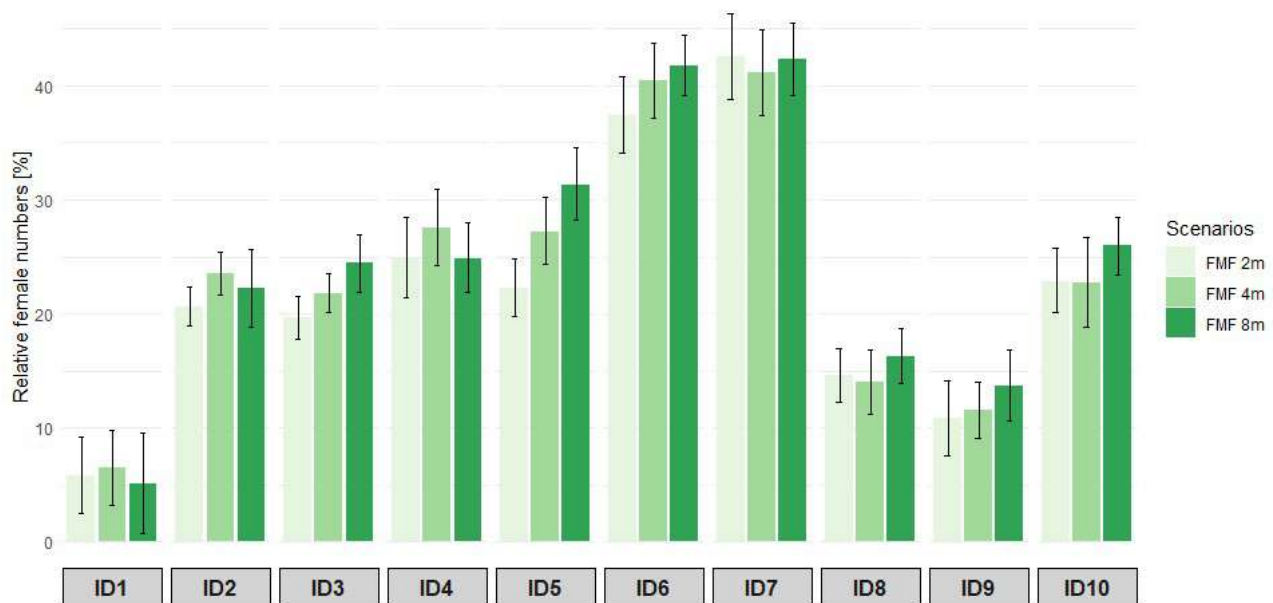


Figure 2.97 Flower field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

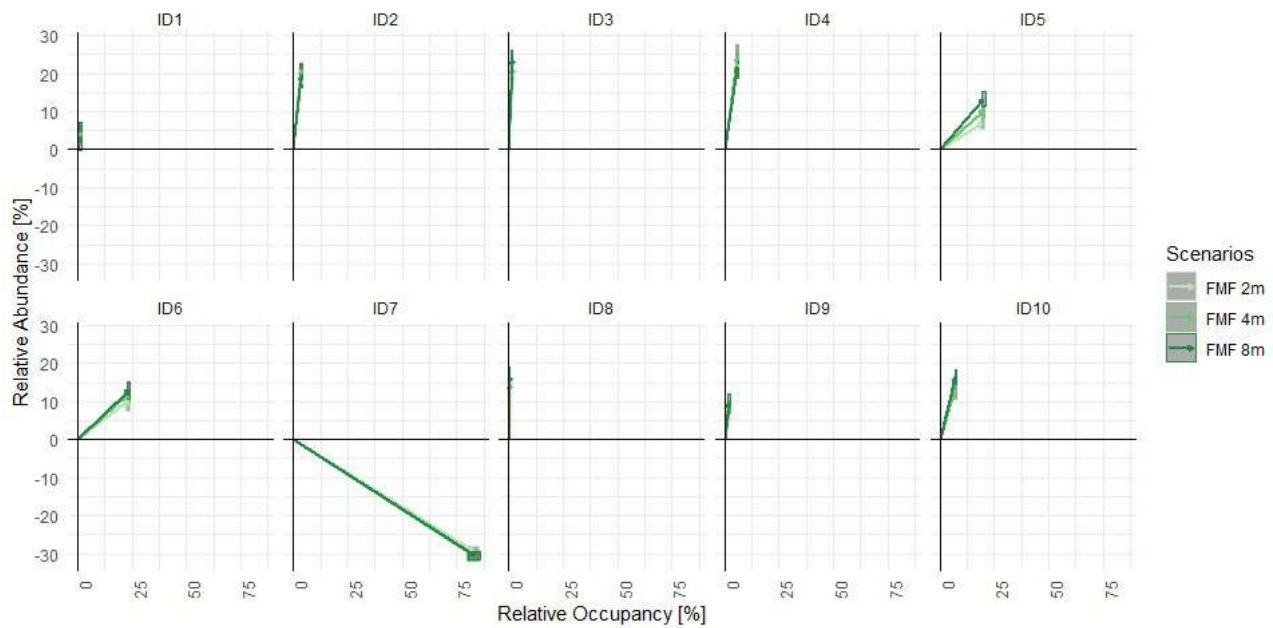


Figure 2.98 Flower field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7.2 Grassy field margins

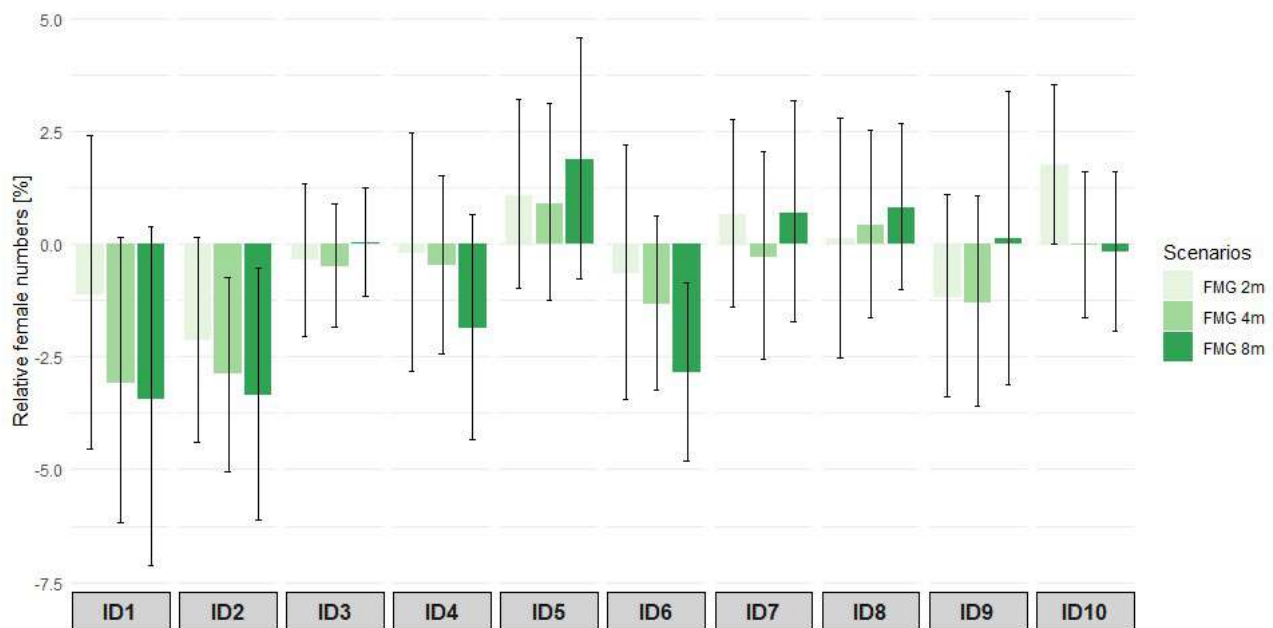


Figure 2.99 Grassy field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

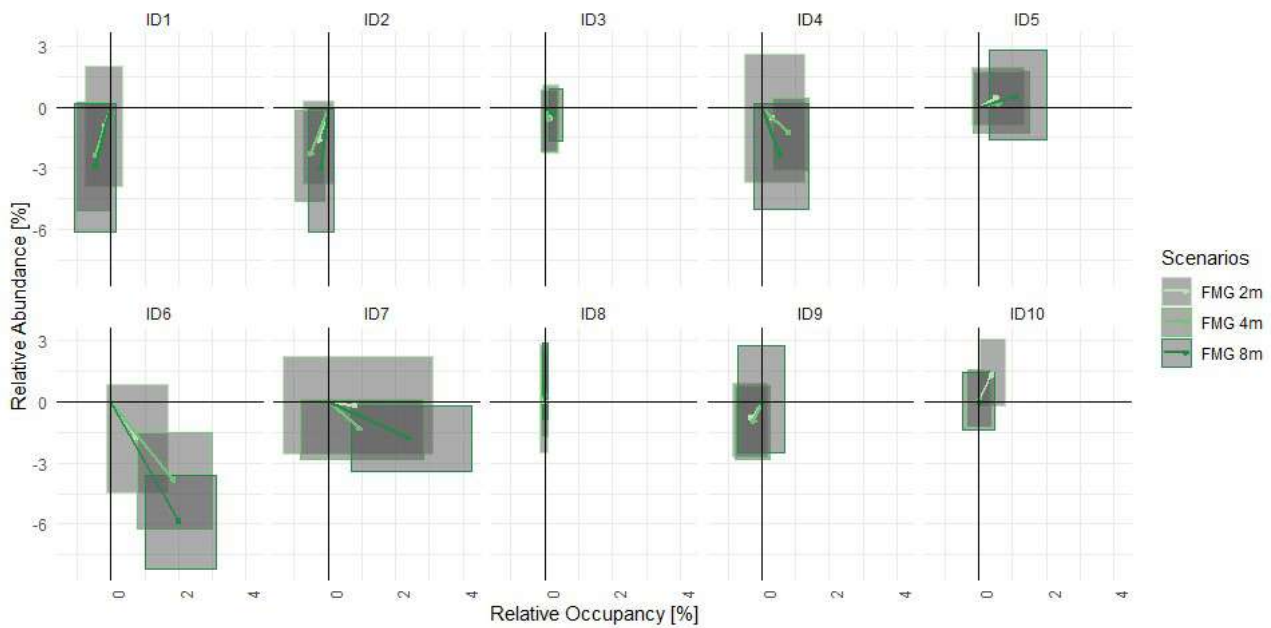


Figure 2.100 Grassy field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7.3 Mixed field margins

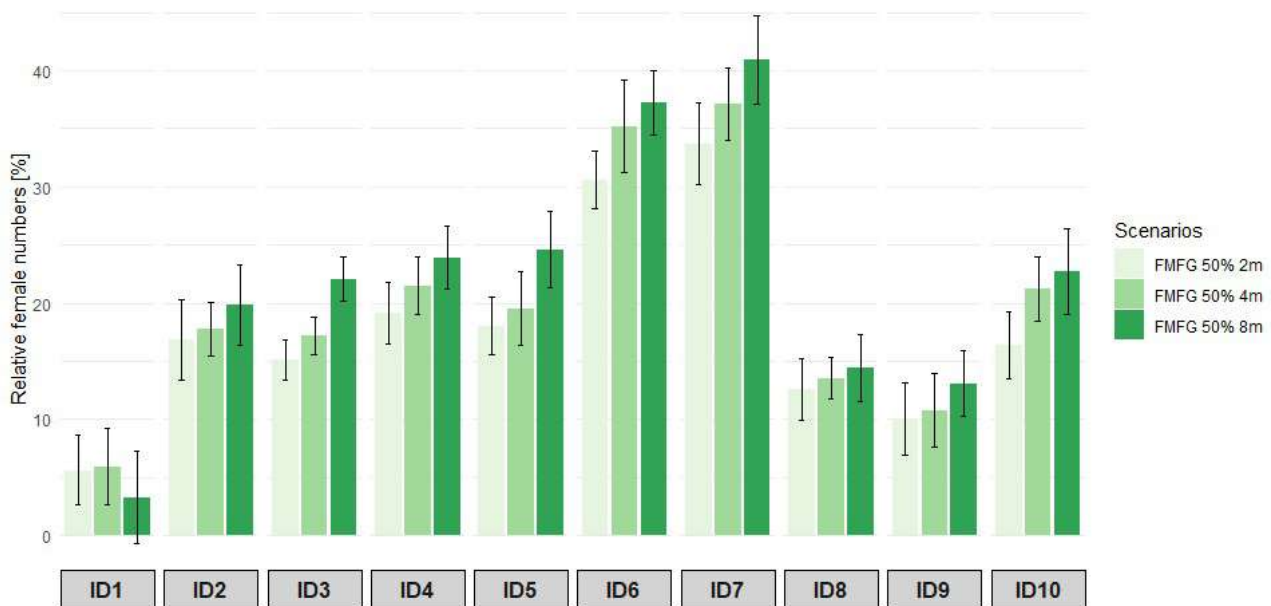


Figure 2.101 Mixed field margins scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

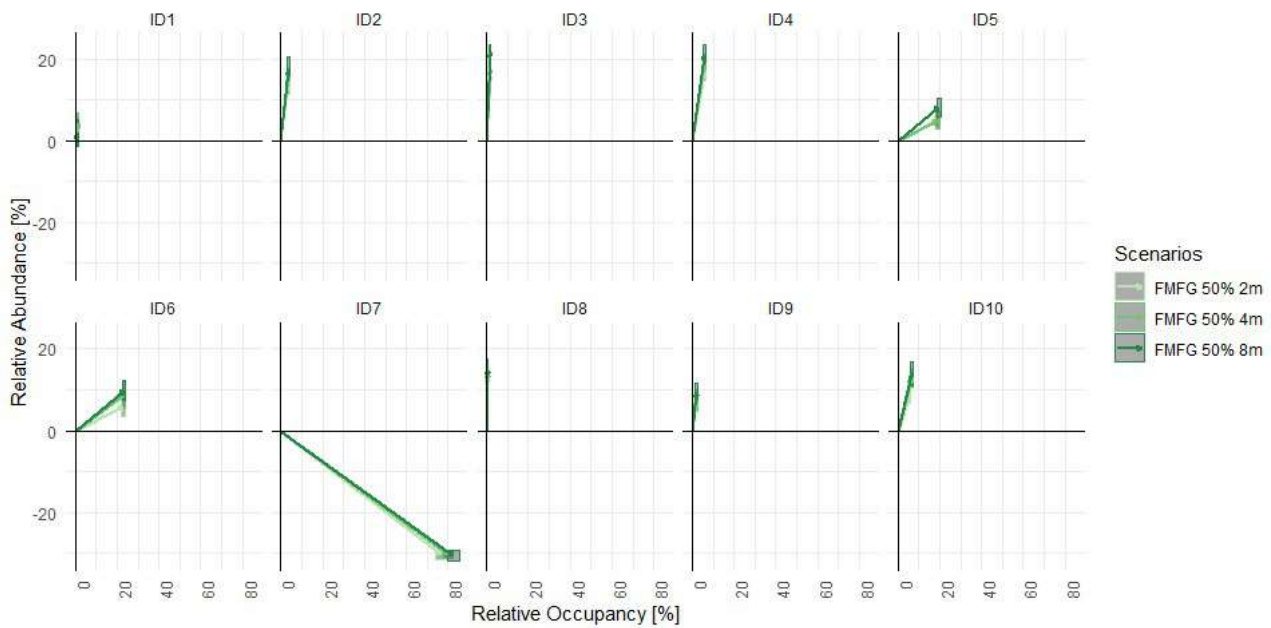


Figure 2.102 Mixed field margins with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7.4 Flower, grassy and mixed field margins

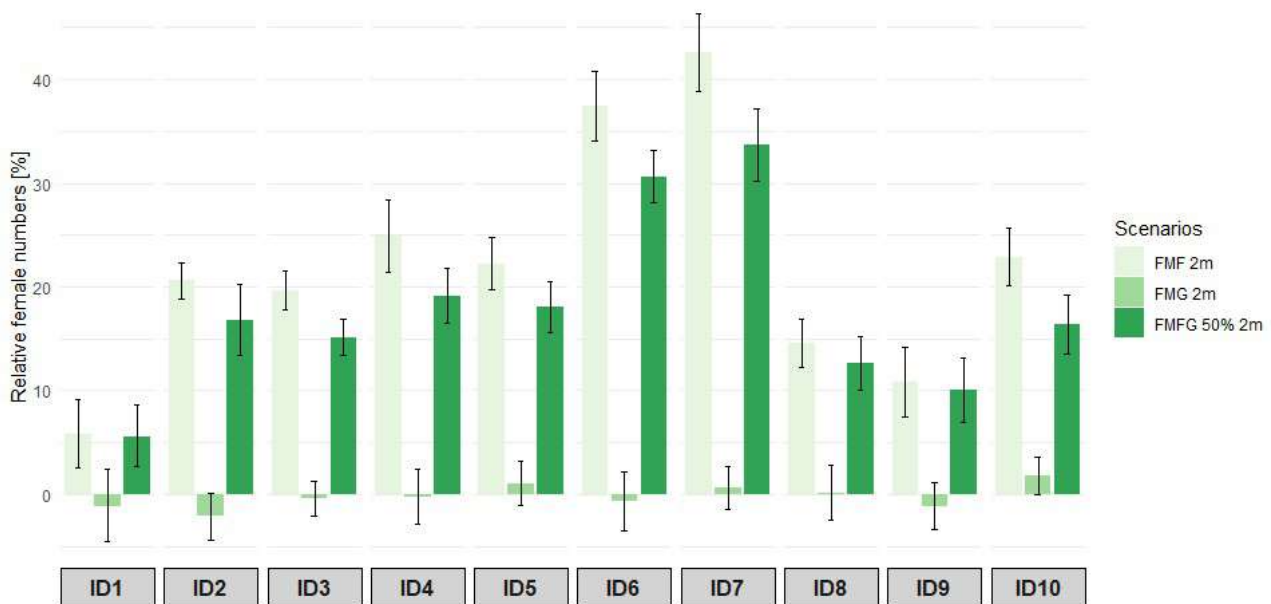


Figure 2.103 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

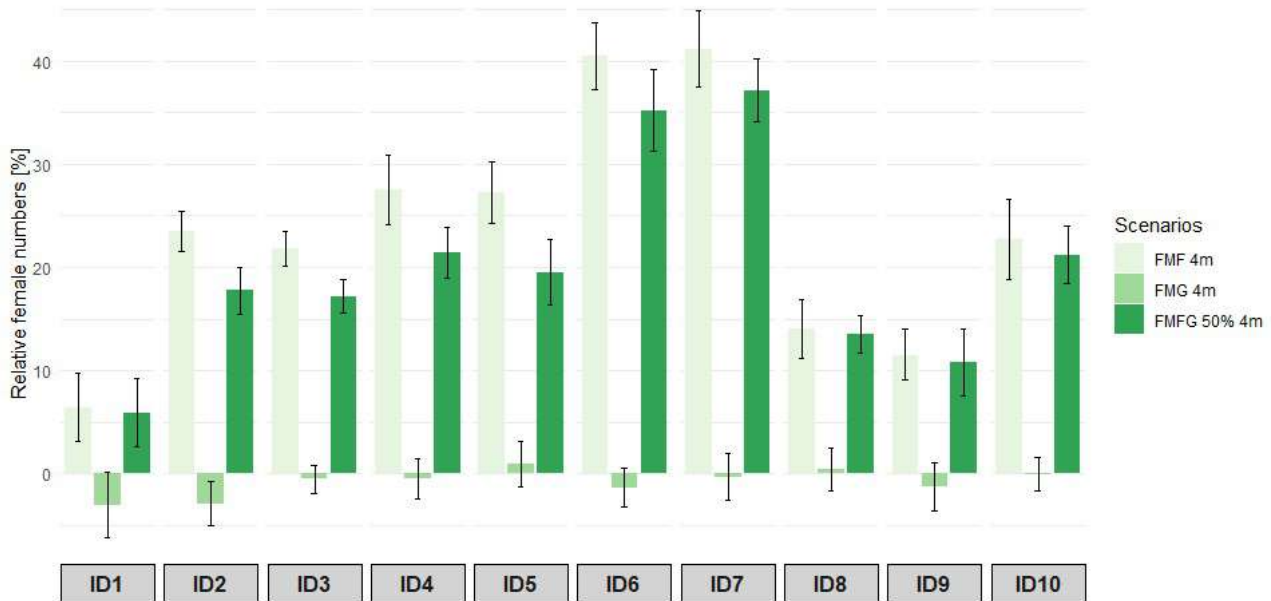


Figure 2.104 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

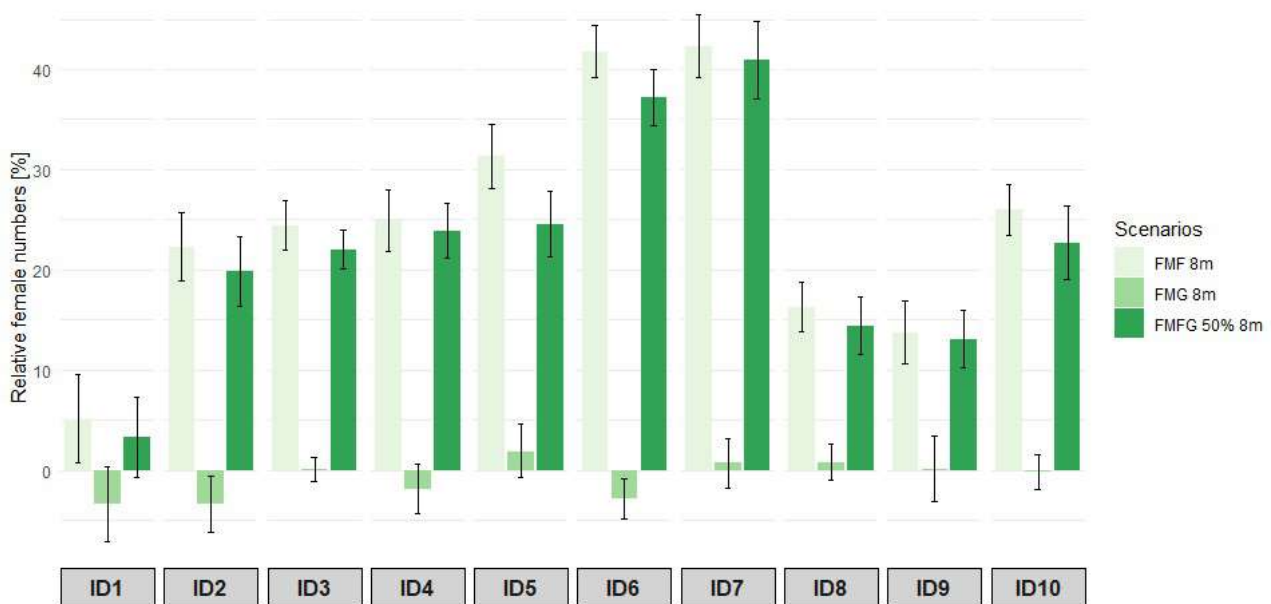


Figure 2.105 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

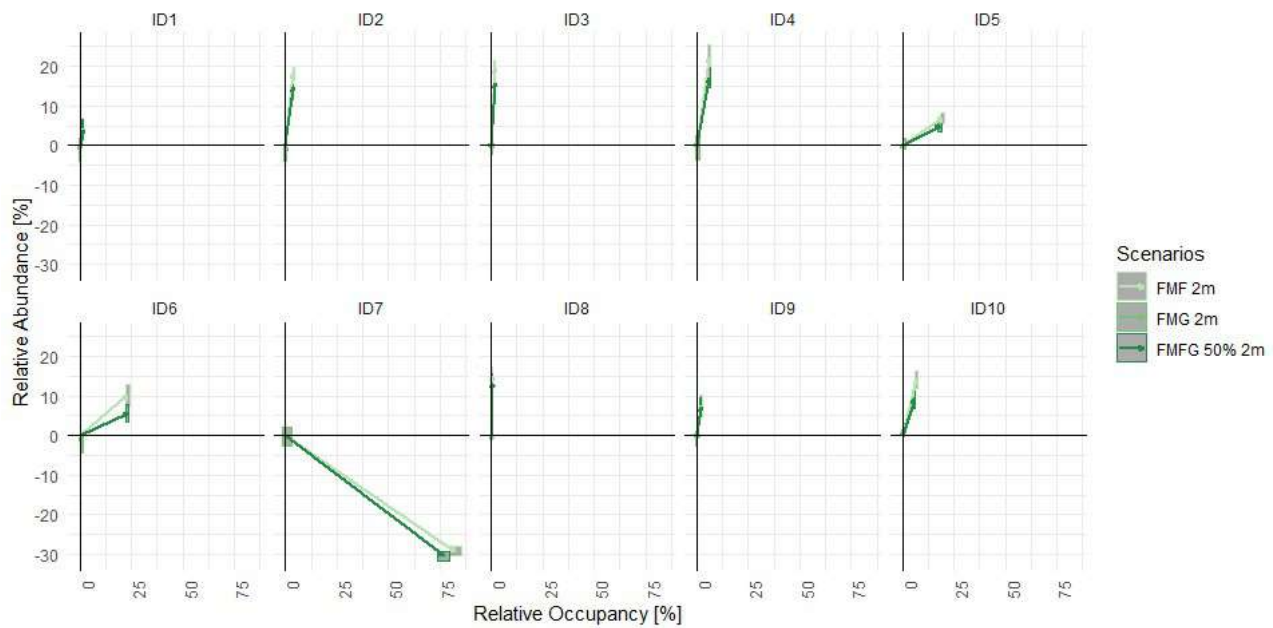


Figure 2.106 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

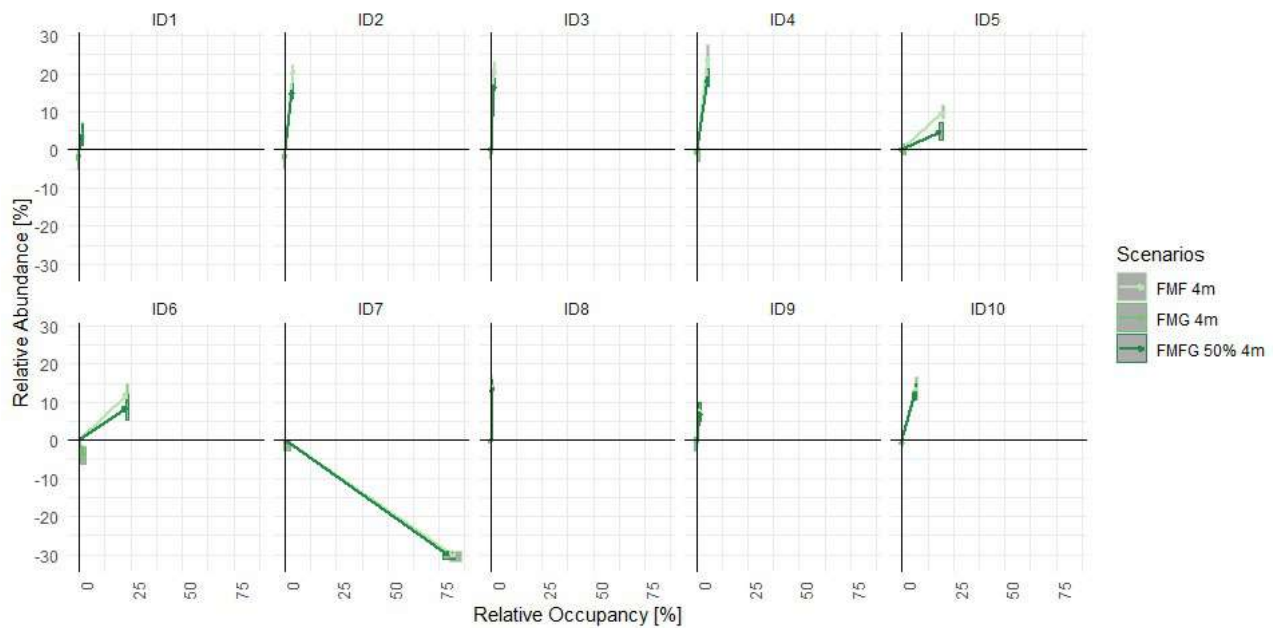


Figure 2.107 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes..

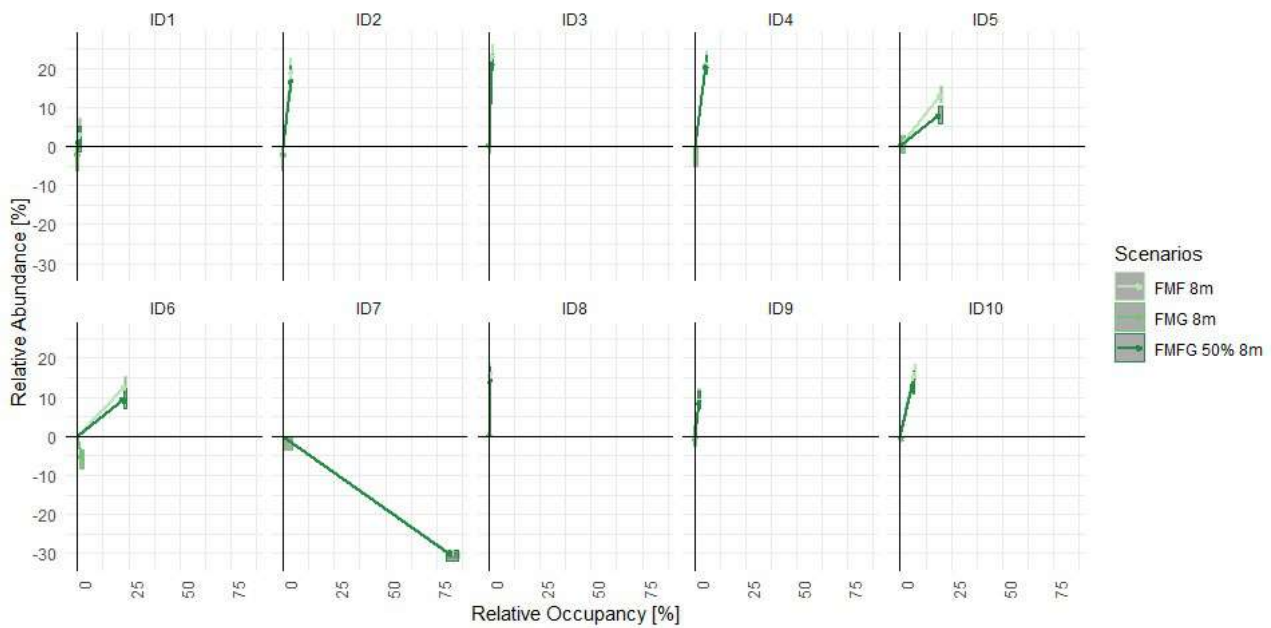


Figure 2.108 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7.5 Setaside

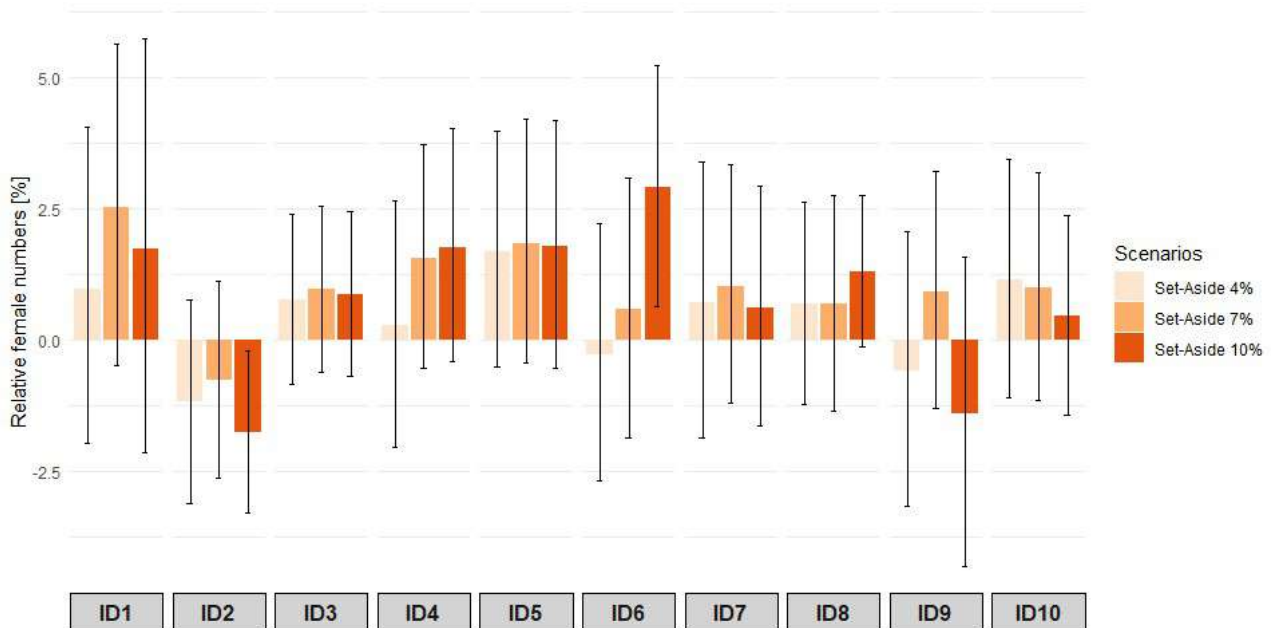


Figure 2.109 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

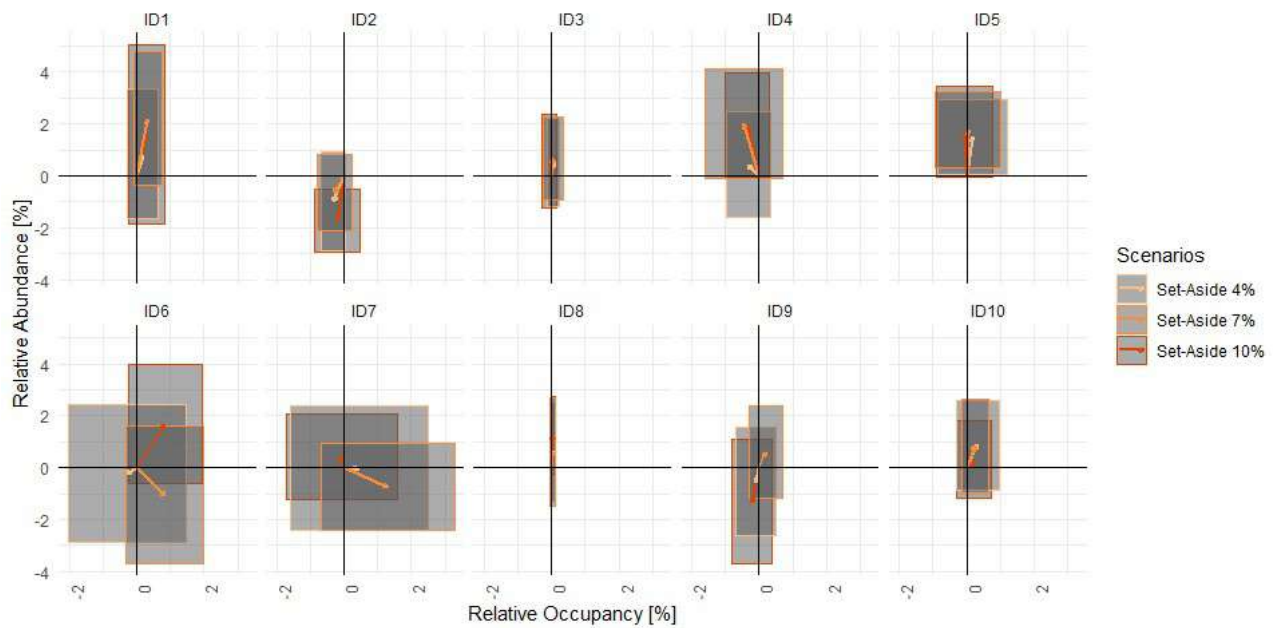


Figure 2.110 Setaside scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7.6 Legume

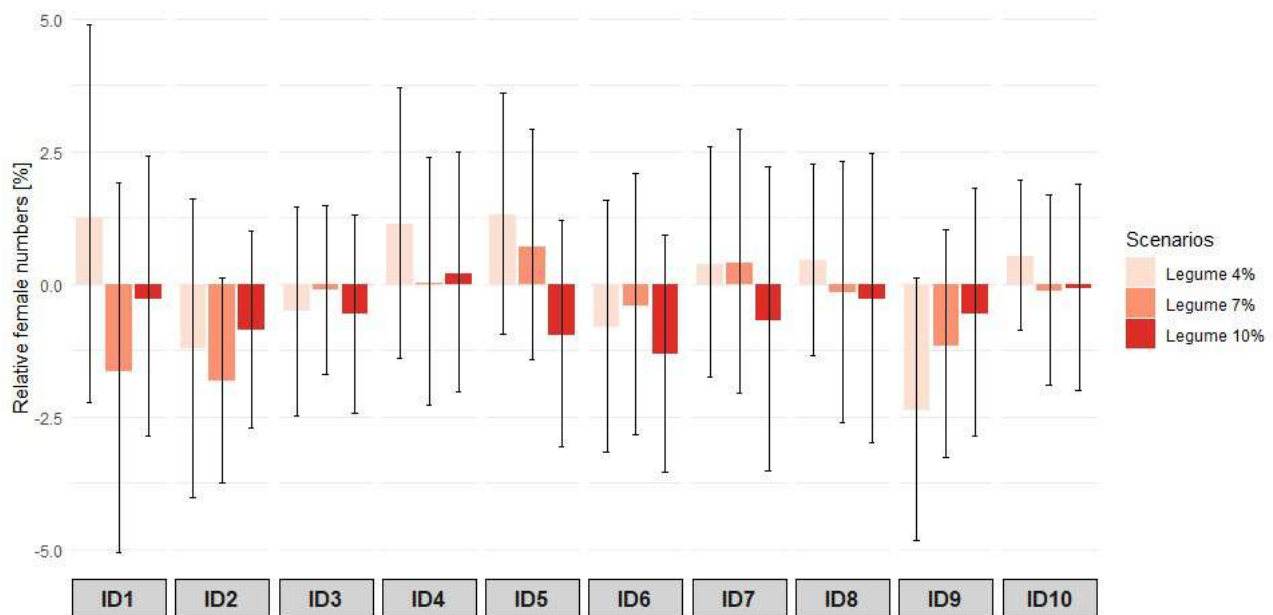


Figure 2.111 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

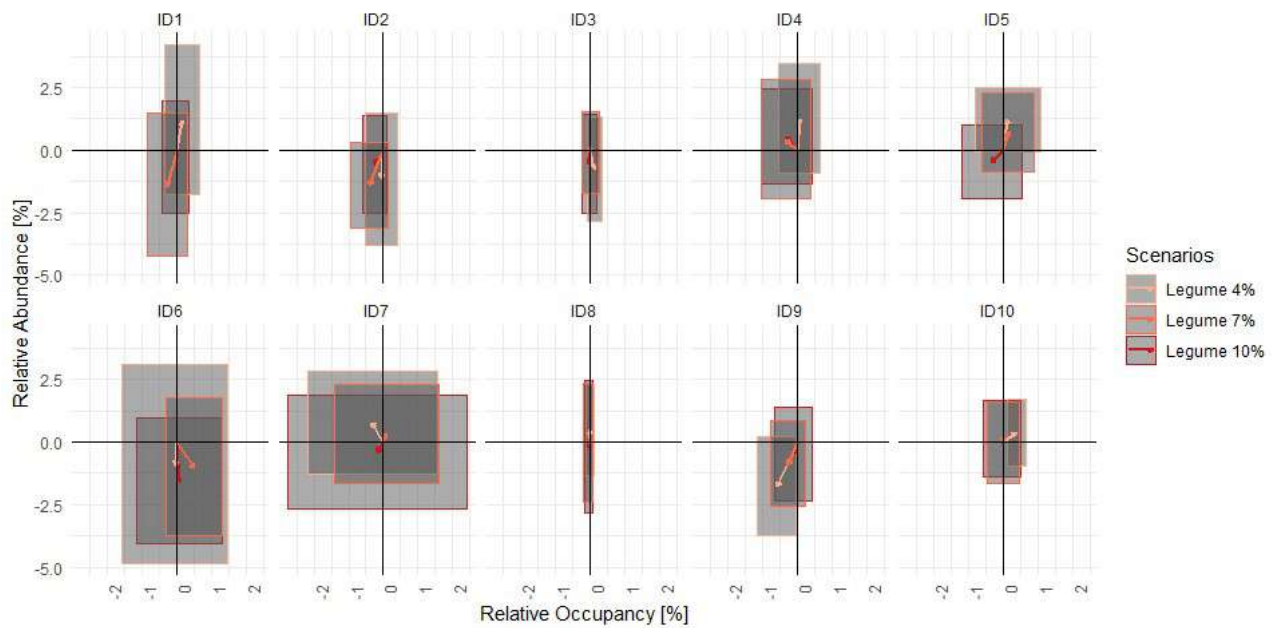


Figure 2.112 Legume scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.7.7 Biopesticides

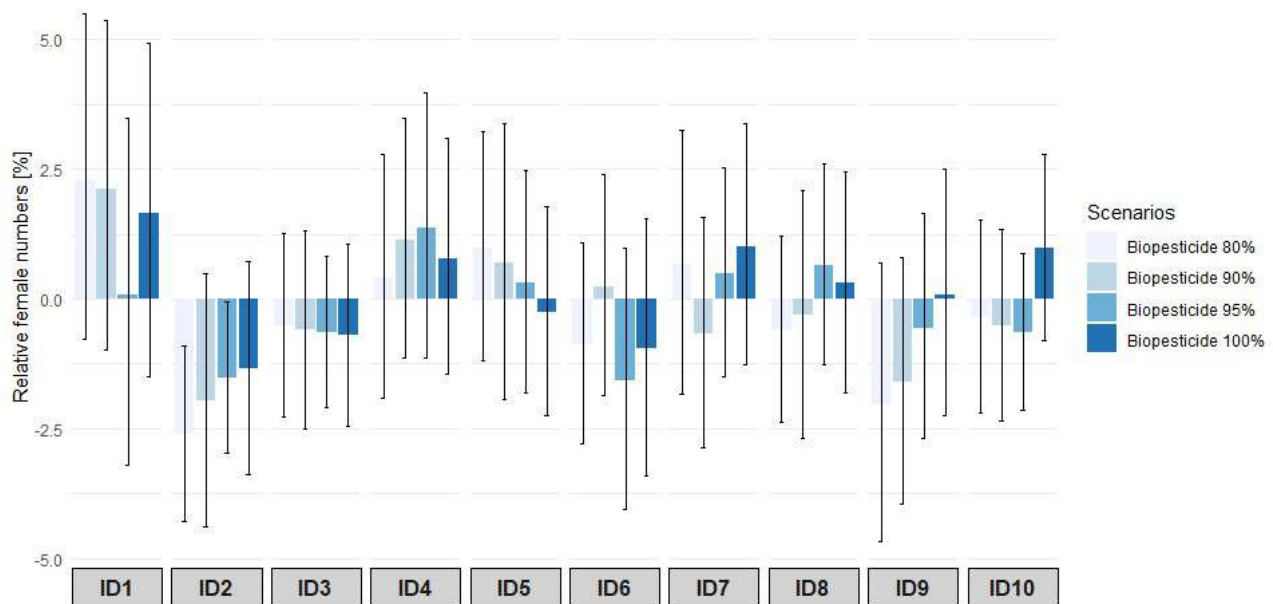


Figure 2.113 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

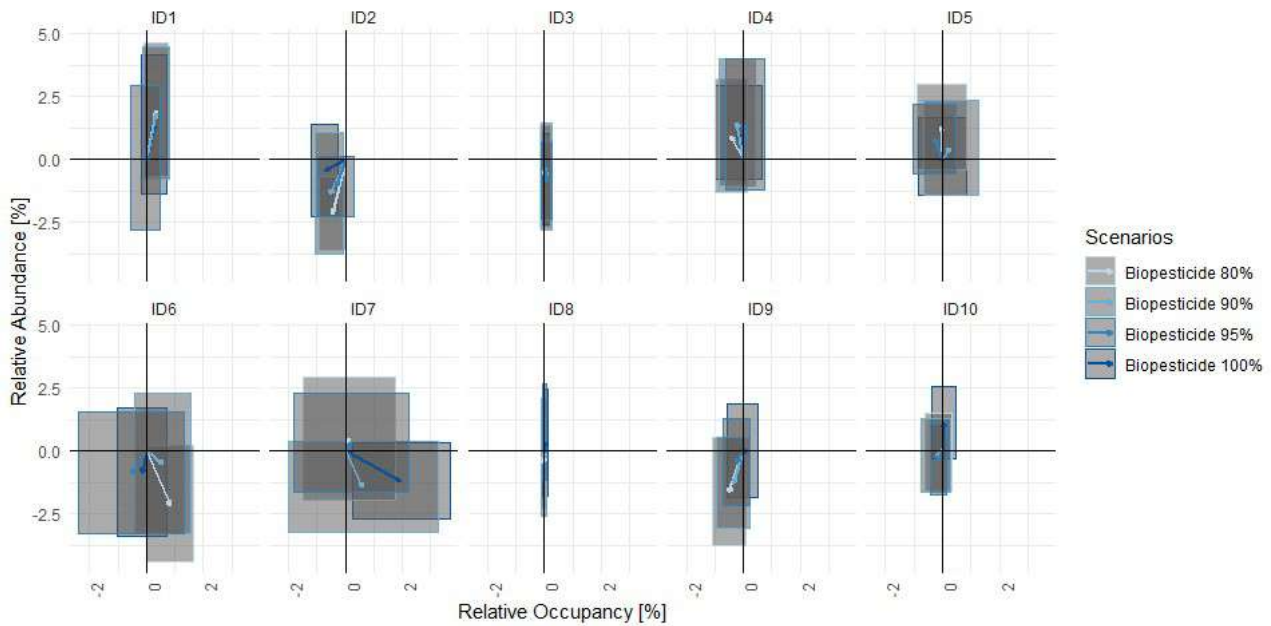


Figure 2.114 Biopesticide scenario with relative change in occupancy and abundance of female *Osmia* compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 50m resolution. Grey areas indicate standard deviation along both axes.

2.8 Combined landscapes

2.8.1 Crop diversification

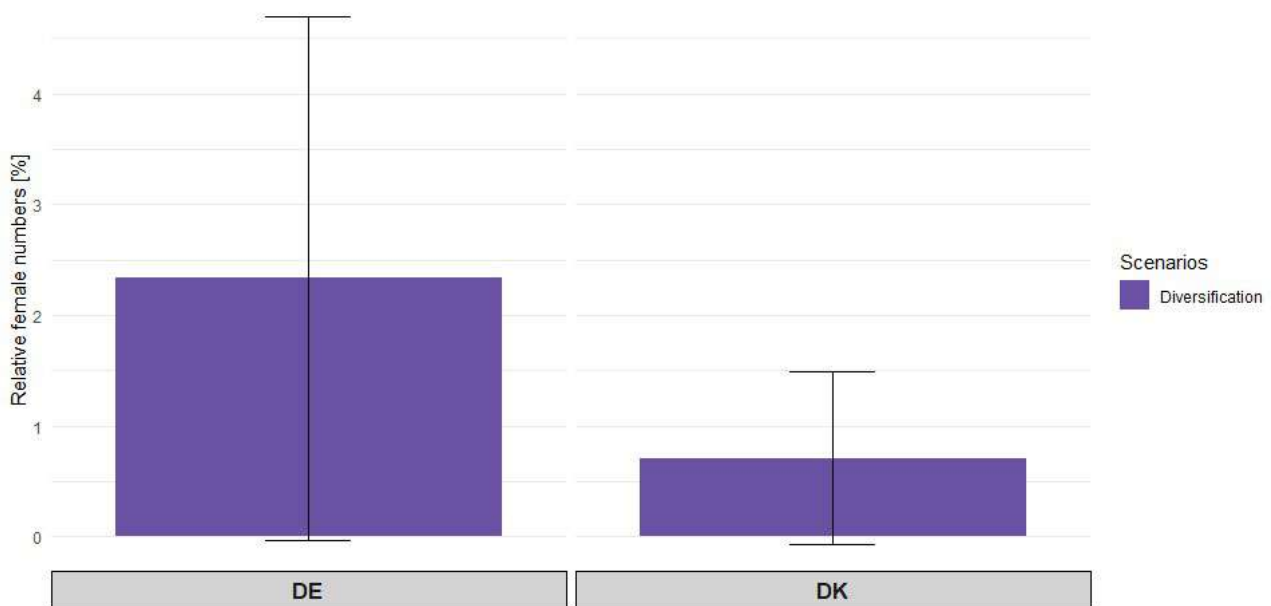


Figure 2.115 Diversification scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.2 Flower field margins

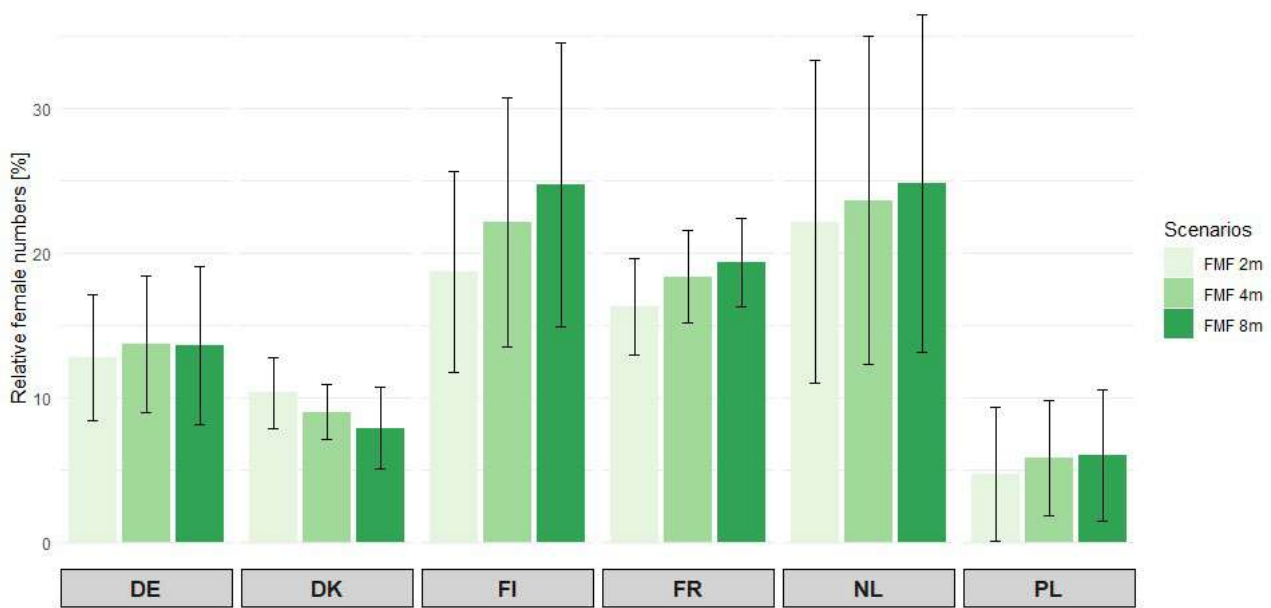


Figure 2.116 Flower field margins with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.3 Grassy field margins

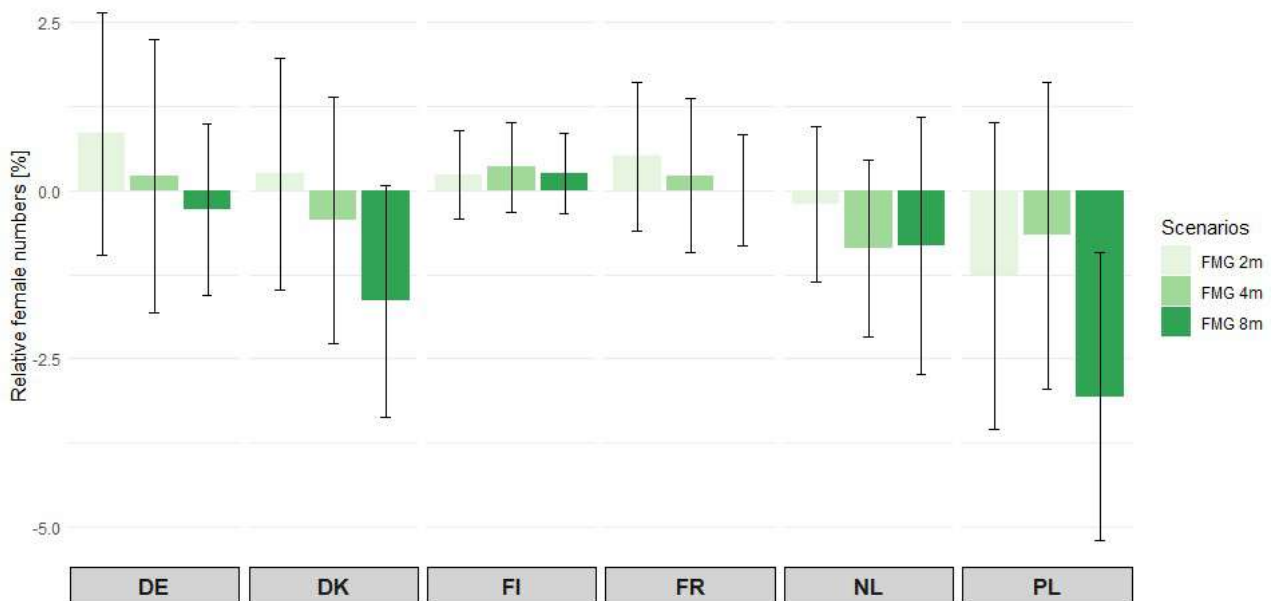


Figure 2.117 Grassy field margins with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.4 Mixed field margins

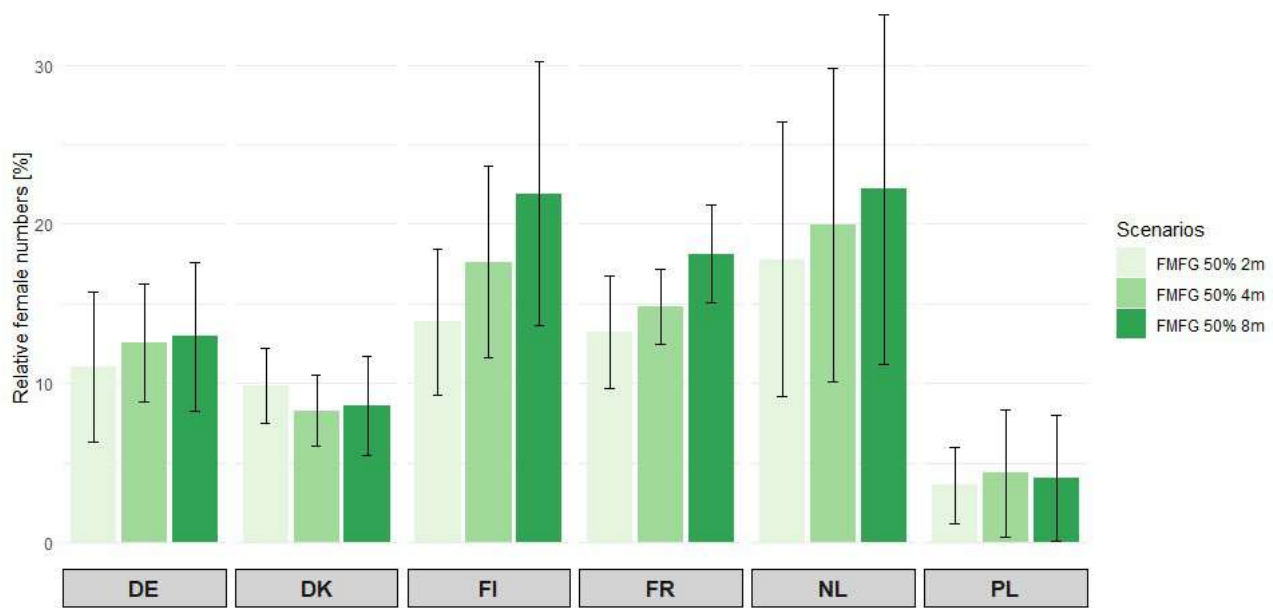


Figure 2.118 Mixed field margins with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.5 Flower, grassy and mixed margins

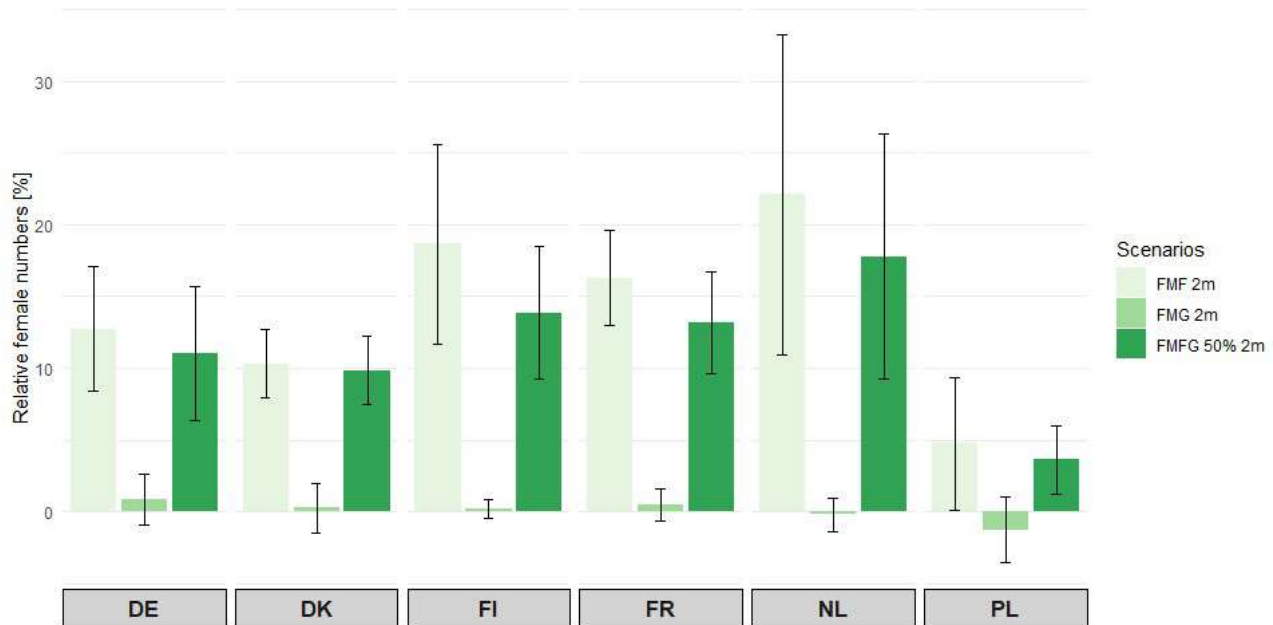


Figure 2.119 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

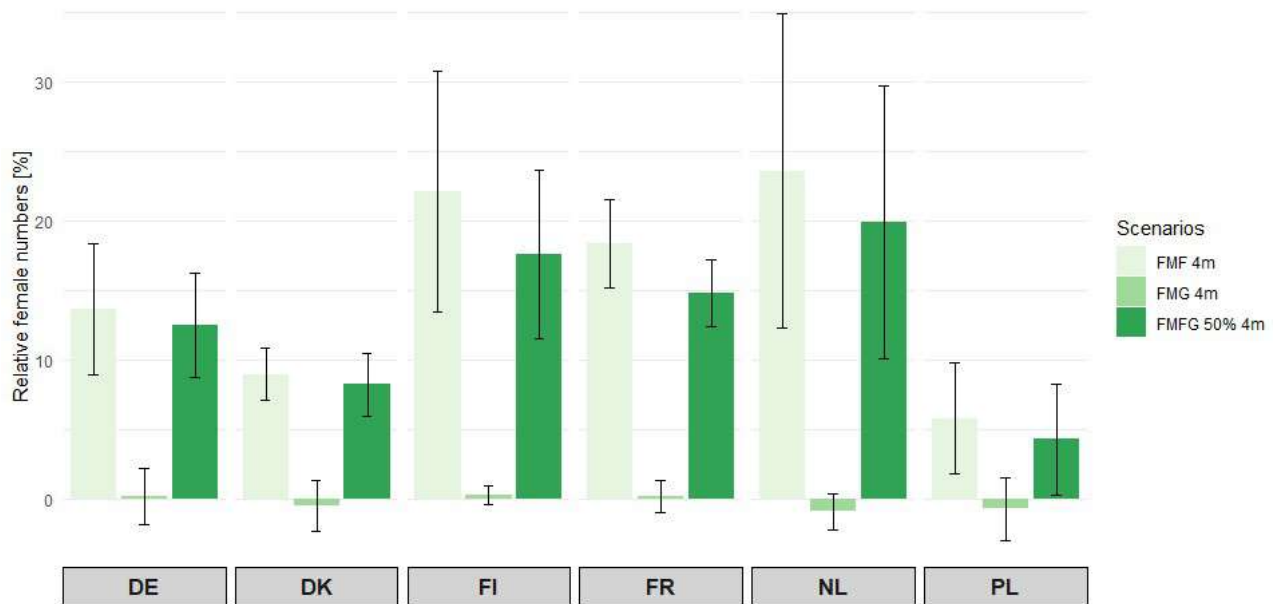


Figure 2.120 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

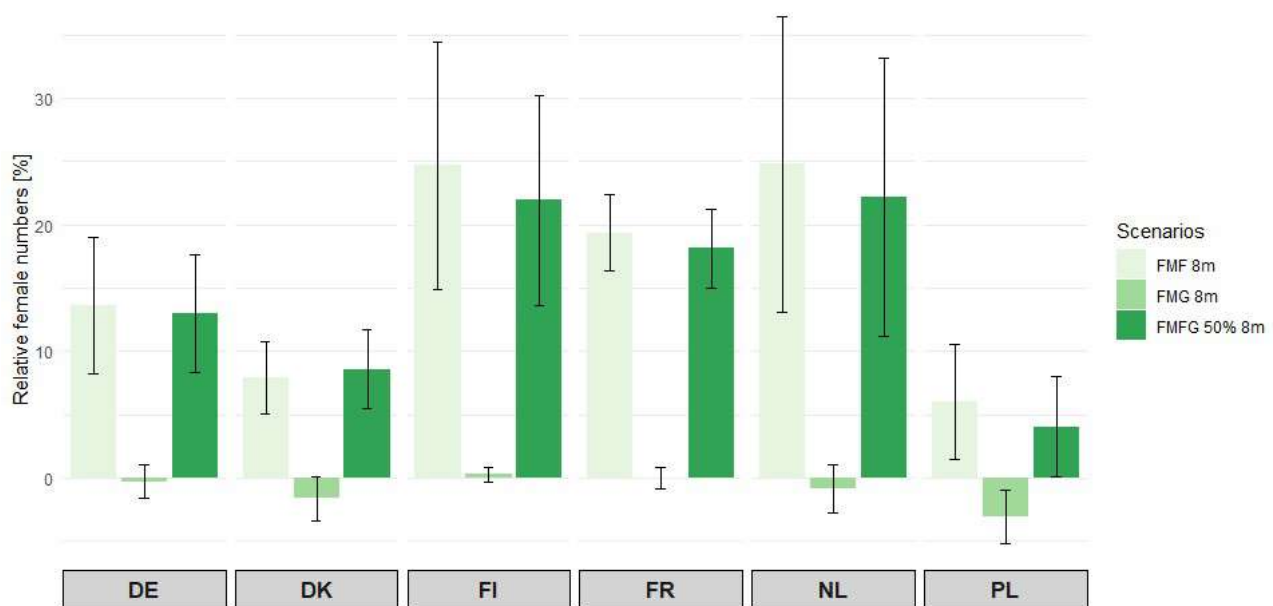


Figure 2.121 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.6 Setaside

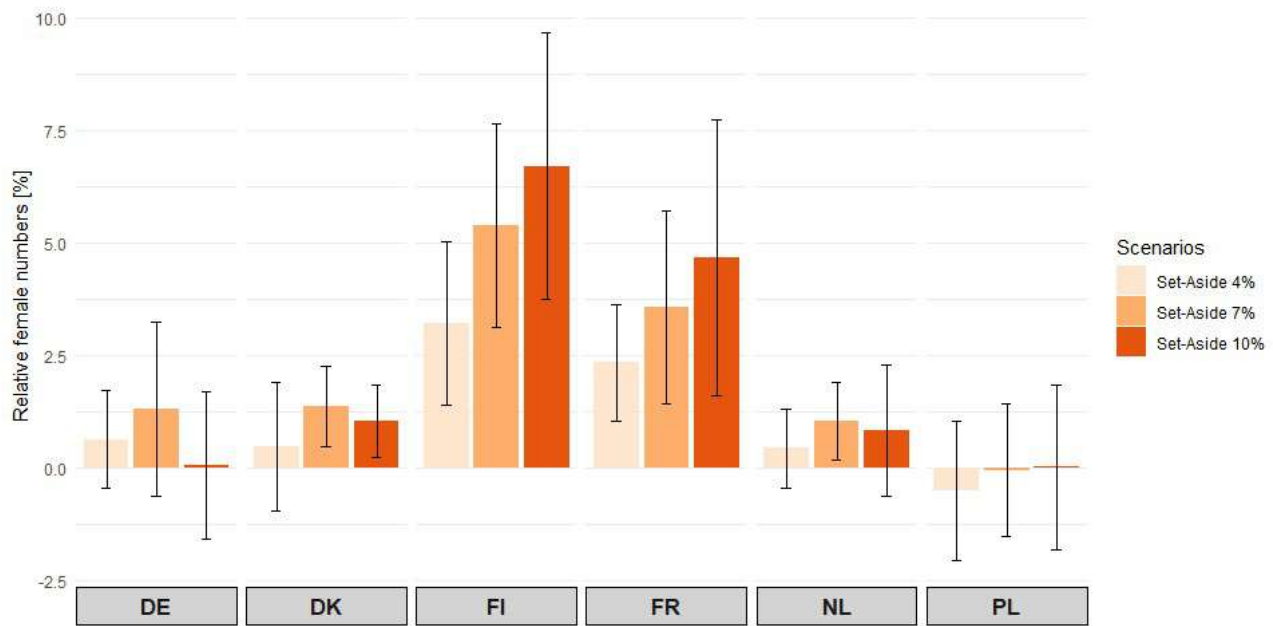


Figure 2.122 Setaside scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.7 Legume

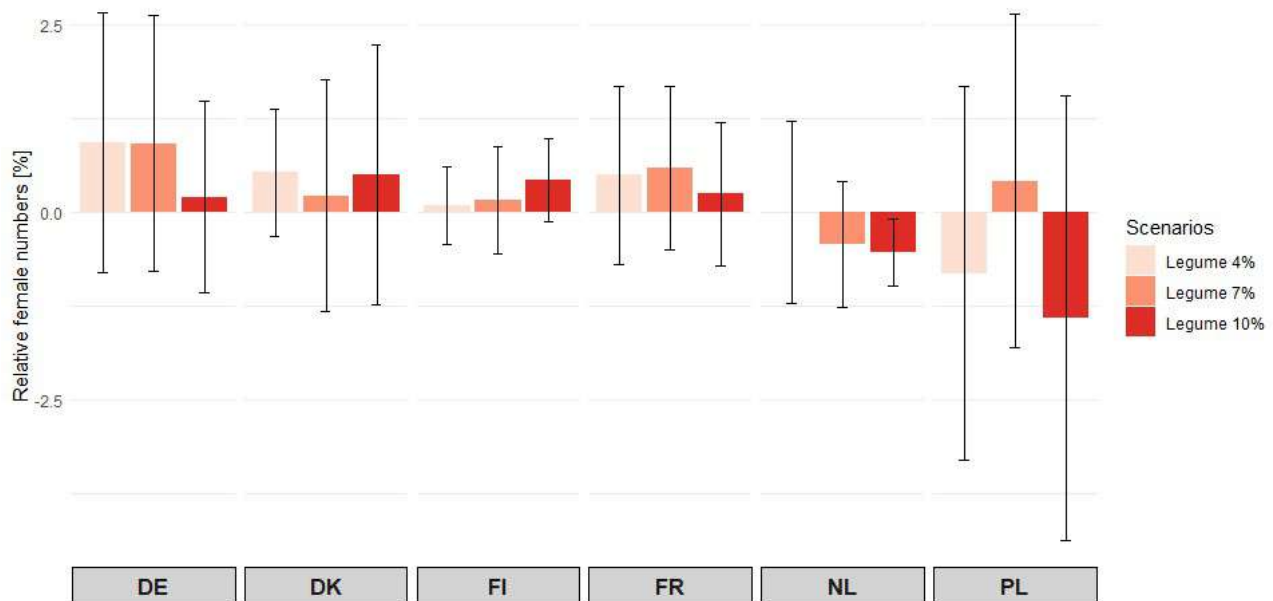


Figure 2.123 Legume scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

2.8.8 Biopesticides

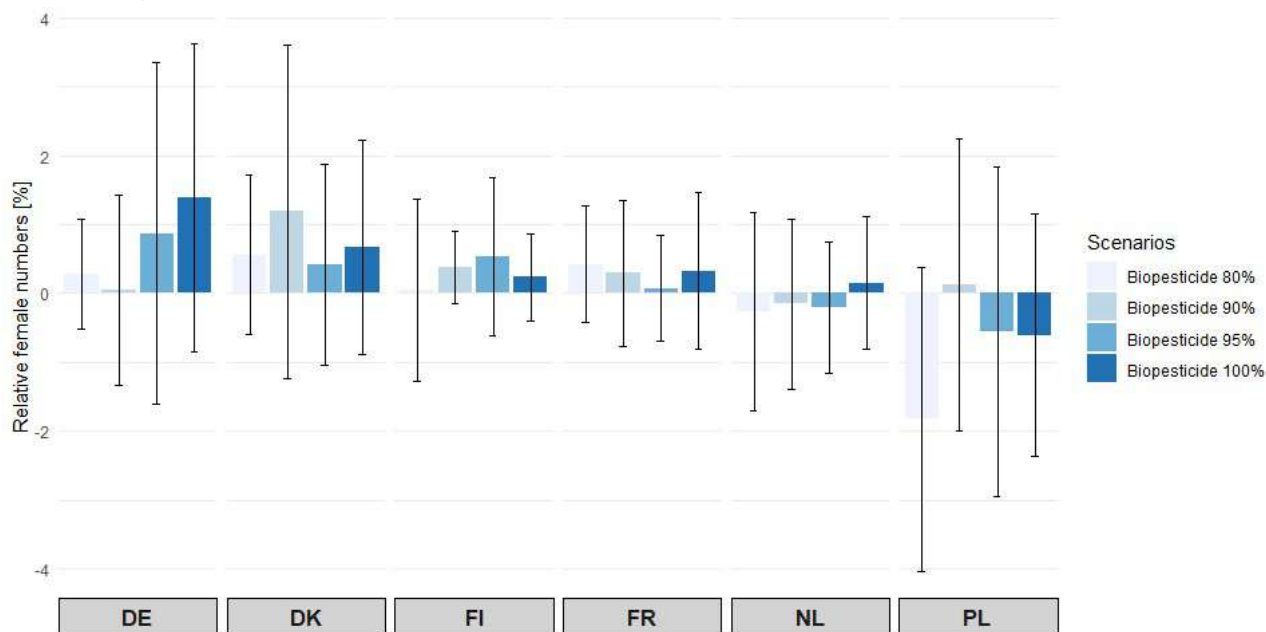


Figure 2.124 Biopesticide scenario with relative change in the number of female *Osmia* compared to baseline and standard deviation presented by error bars for each simulated country.

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2.8.9 Table: Country level overview of scenario effects

Table 2.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for *Osmia*. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	NL	PL	FR	FI
Diversification	2% (SD 2%)	1% (SD 1%)	NA	NA	NA	NA
FMF 2m	13% (SD 4%)	10% (SD 2%)	22% (SD 11%)	5% (SD 5%)	16% (SD 3%)	19% (SD 7%)
FMF 4m	14% (SD 5%)	9% (SD 2%)	24% (SD 11%)	6% (SD 4%)	18% (SD 3%)	22% (SD 9%)
FMF 8m	14% (SD 5%)	8% (SD 3%)	25% (SD 12%)	6% (SD 5%)	19% (SD 3%)	25% (SD 10%)
FMG 2m	1% (SD 2%)	0% (SD 2%)	-0% (SD 1%)	-1% (SD 2%)	1% (SD 1%)	0% (SD 1%)
FMG 4m	0% (SD 2%)	-0% (SD 2%)	-1% (SD 1%)	-1% (SD 2%)	0% (SD 1%)	0% (SD 1%)

Scenario	DE	DK	NL	PL	FR	FI
FMG 8m	-0% (SD 1%)	-2% (SD 2%)	-1% (SD 2%)	-3% (SD 2%)	0% (SD 1%)	0% (SD 1%)
FMFG 50% 2m	11% (SD 5%)	10% (SD 2%)	18% (SD 9%)	4% (SD 2%)	13% (SD 4%)	14% (SD 5%)
FMFG 50% 4m	13% (SD 4%)	8% (SD 2%)	20% (SD 10%)	4% (SD 4%)	15% (SD 2%)	18% (SD 6%)
FMFG 50% 8m	13% (SD 5%)	9% (SD 3%)	22% (SD 11%)	4% (SD 4%)	18% (SD 3%)	22% (SD 8%)
Set-Aside 4%	1% (SD 1%)	0% (SD 1%)	0% (SD 1%)	-1% (SD 2%)	2% (SD 1%)	3% (SD 2%)
Set-Aside 7%	1% (SD 2%)	1% (SD 1%)	1% (SD 1%)	-0% (SD 1%)	4% (SD 2%)	5% (SD 2%)
Set-Aside 10%	0% (SD 2%)	1% (SD 1%)	1% (SD 1%)	0% (SD 2%)	5% (SD 3%)	7% (SD 3%)
Legume 4%	1% (SD 2%)	1% (SD 1%)	0% (SD 1%)	-1% (SD 2%)	0% (SD 1%)	0% (SD 1%)
Legume 7%	1% (SD 2%)	0% (SD 2%)	-0% (SD 1%)	0% (SD 2%)	1% (SD 1%)	0% (SD 1%)
Legume 10%	0% (SD 1%)	0% (SD 2%)	-1% (SD 0%)	-1% (SD 3%)	0% (SD 1%)	0% (SD 1%)
Biopesticide 80%	0% (SD 1%)	1% (SD 1%)	-0% (SD 1%)	-2% (SD 2%)	0% (SD 1%)	0% (SD 1%)
Biopesticide 90%	0% (SD 1%)	1% (SD 2%)	-0% (SD 1%)	0% (SD 2%)	0% (SD 1%)	0% (SD 1%)
Biopesticide 95%	1% (SD 2%)	0% (SD 1%)	-0% (SD 1%)	-1% (SD 2%)	0% (SD 1%)	1% (SD 1%)
Biopesticide 100%	1% (SD 2%)	1% (SD 2%)	0% (SD 1%)	-1% (SD 2%)	0% (SD 1%)	0% (SD 1%)

3 BEMBIDION

3.1 Baselines



Figure 3.1 Bembidion baselines for each country and landscape.

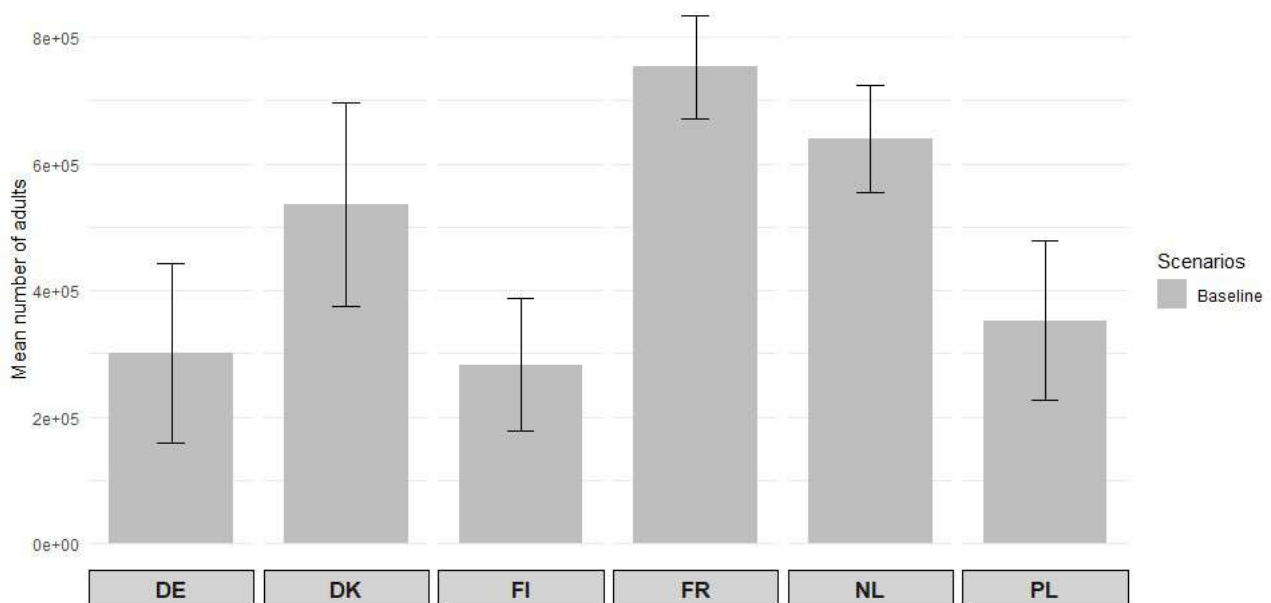


Figure 3.2 Bembidion baselines for each country combined across landscapes.

3.2 Germany

3.2.1 Crop diversification

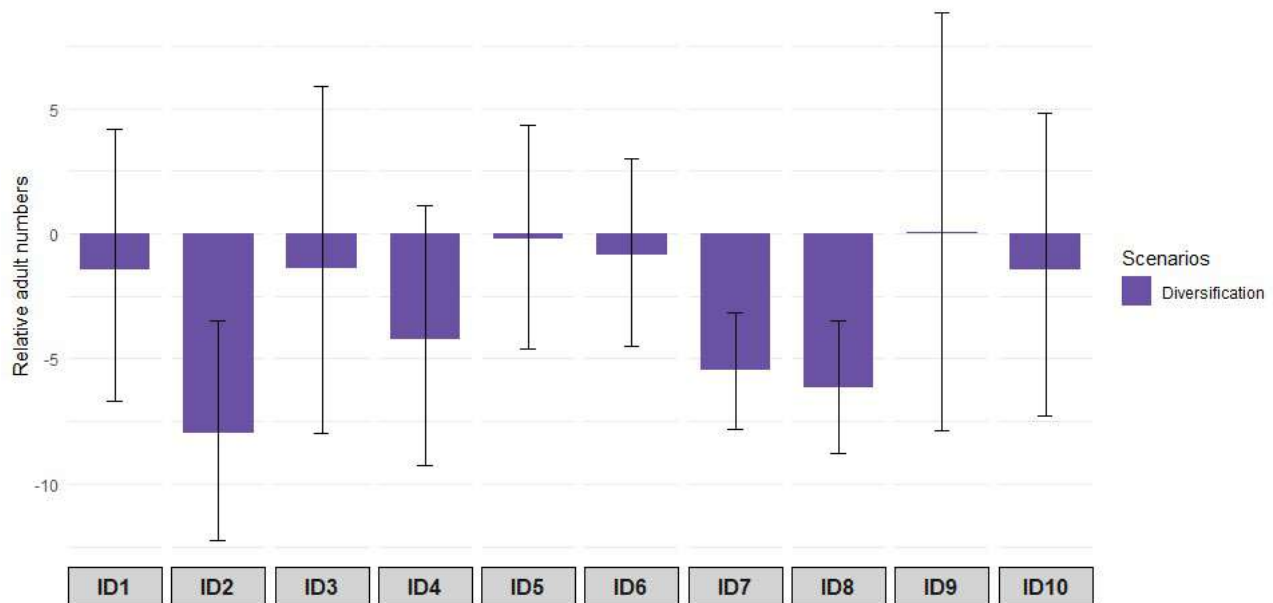


Figure 3.3 Diversification scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

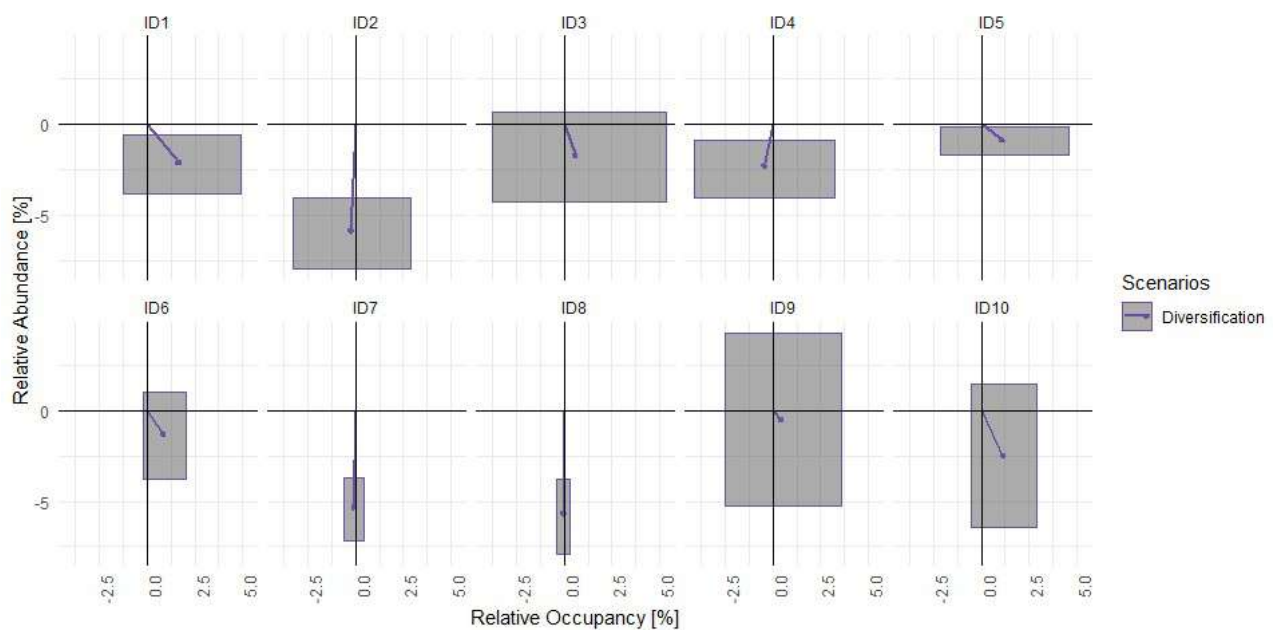


Figure 3.4 Diversification scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.2 Flower field margins

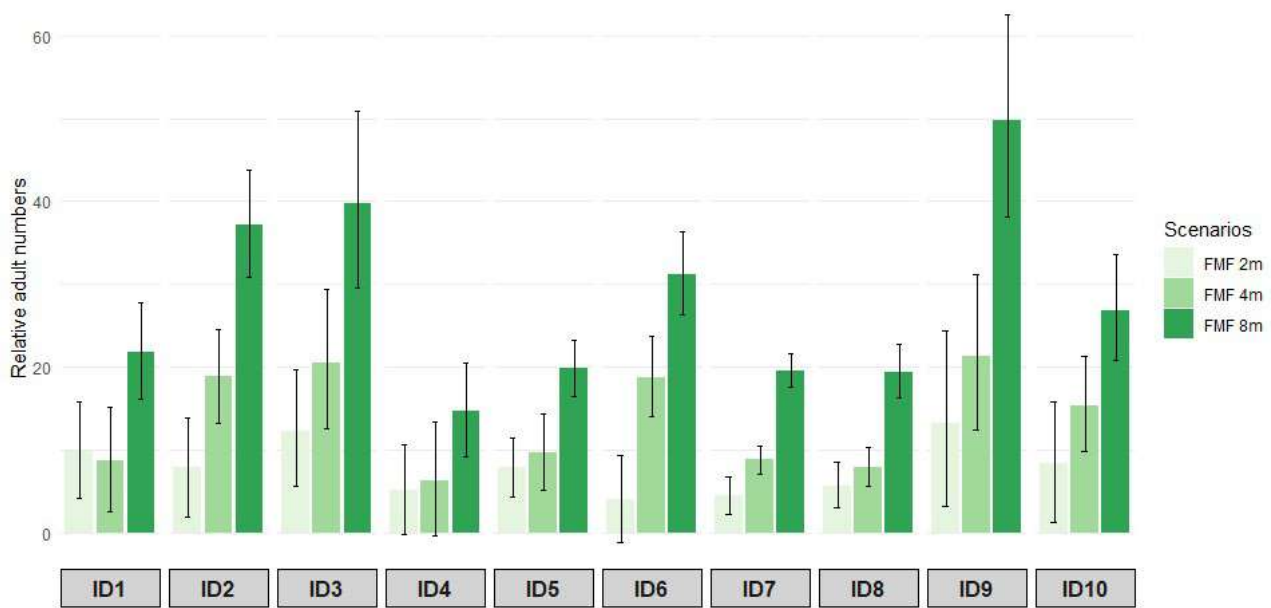


Figure 3.5 Flower field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

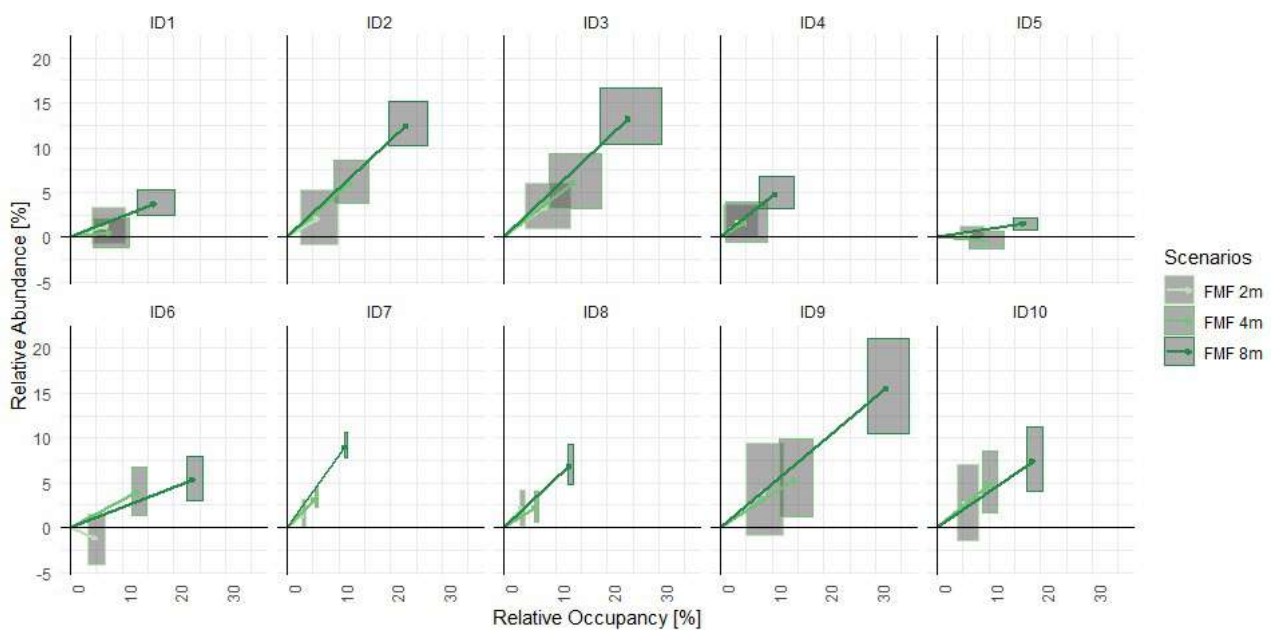


Figure 3.6 Flower field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.3 Grassy field margins

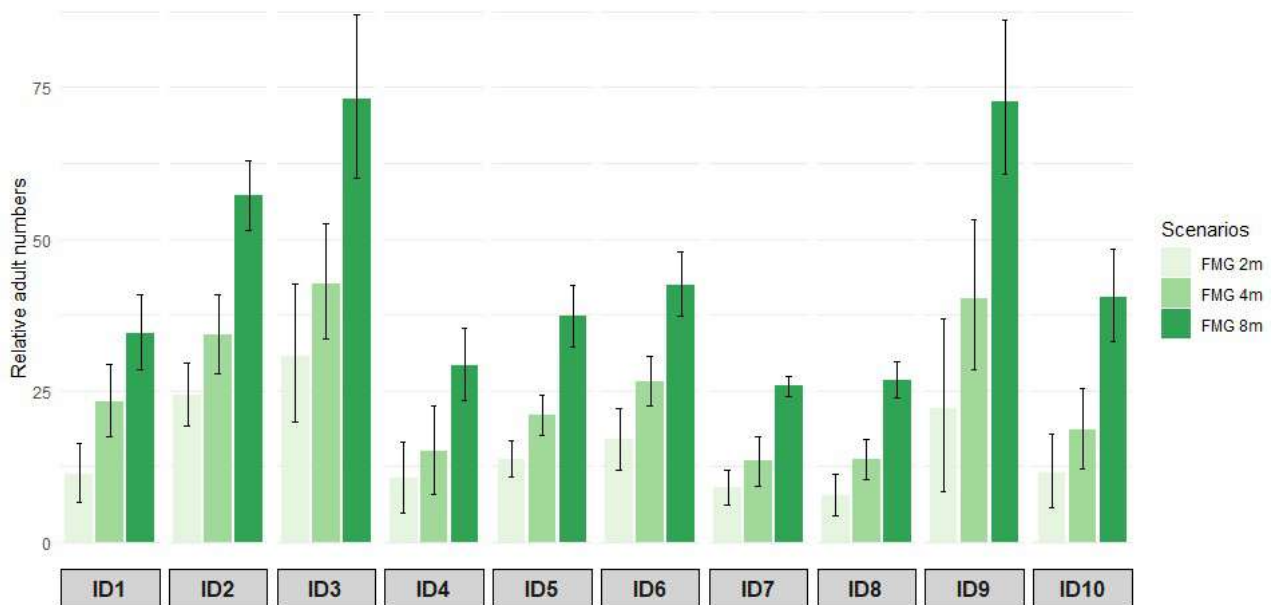


Figure 3.7 Grassy field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

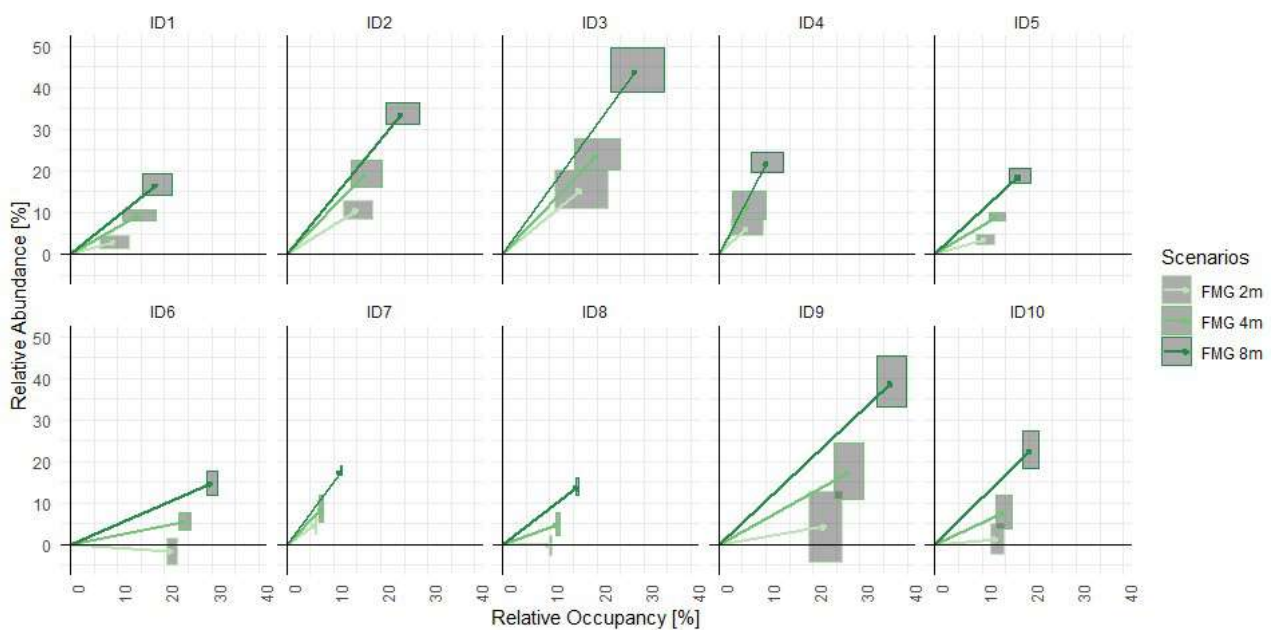


Figure 3.8 Grassy field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.4 Mixed field margins

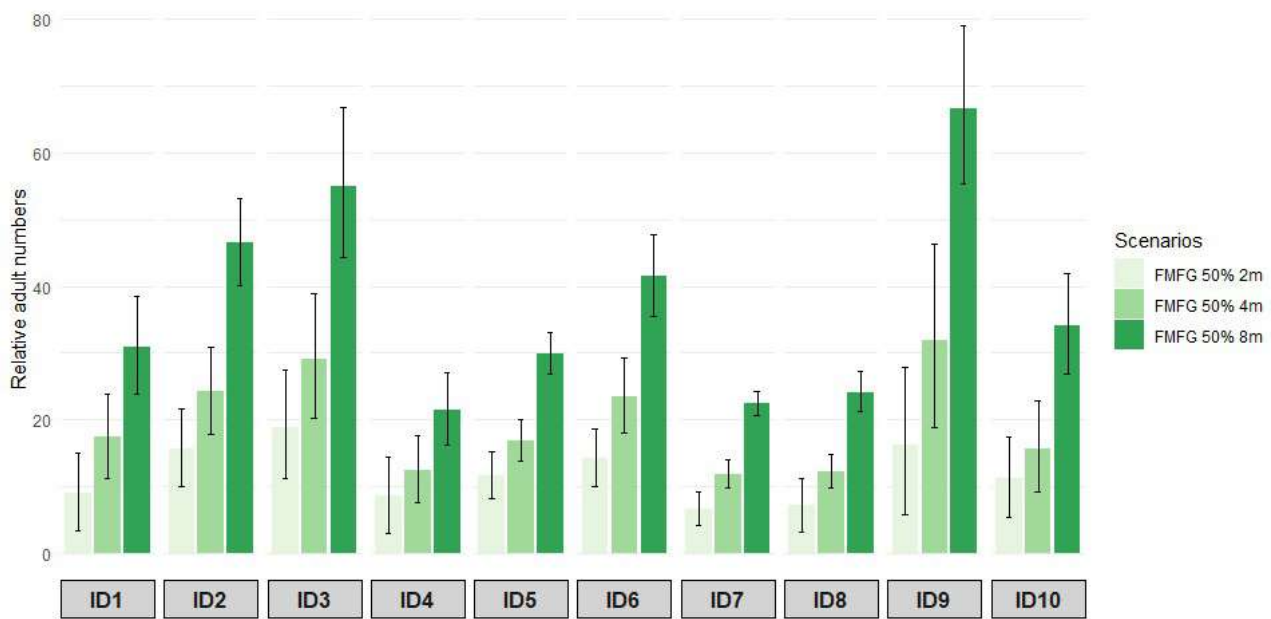


Figure 3.9 Mixed field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

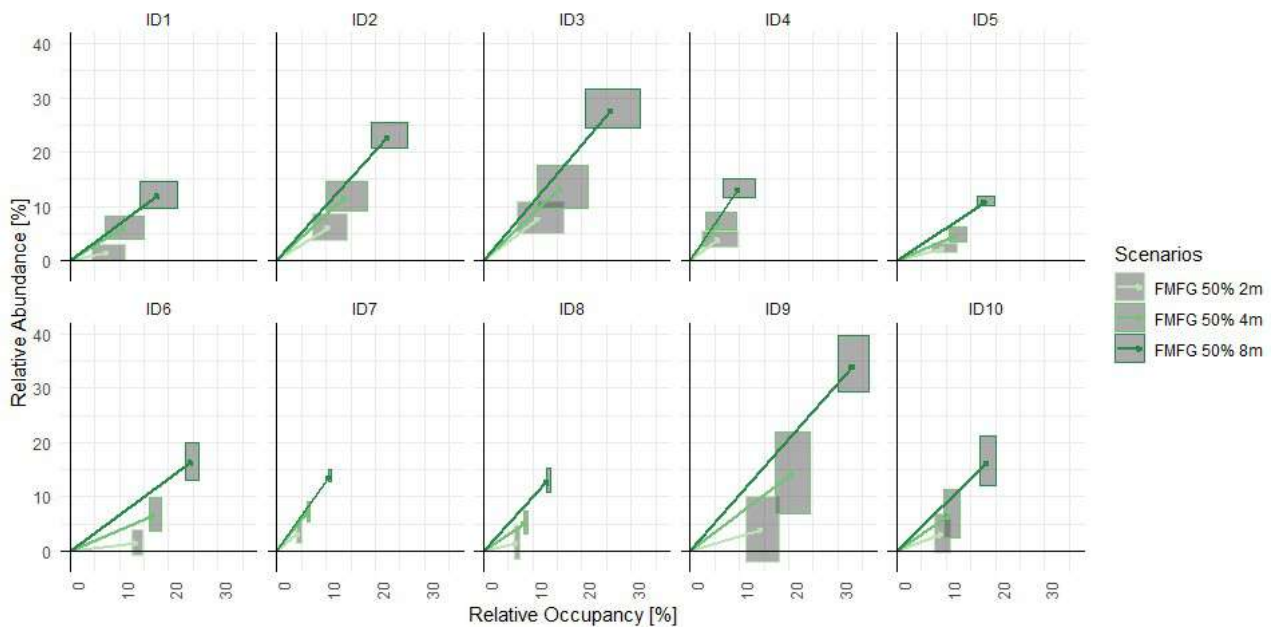


Figure 3.10 Mixed field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.5 Flower, grassy and mixed field margins

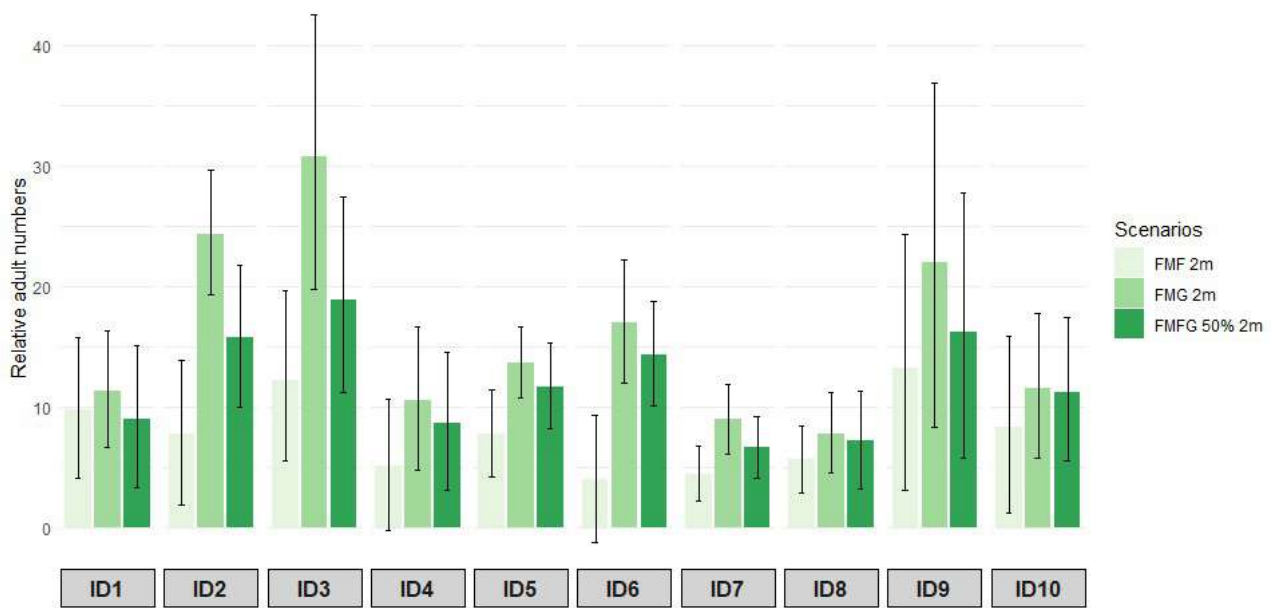


Figure 3.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

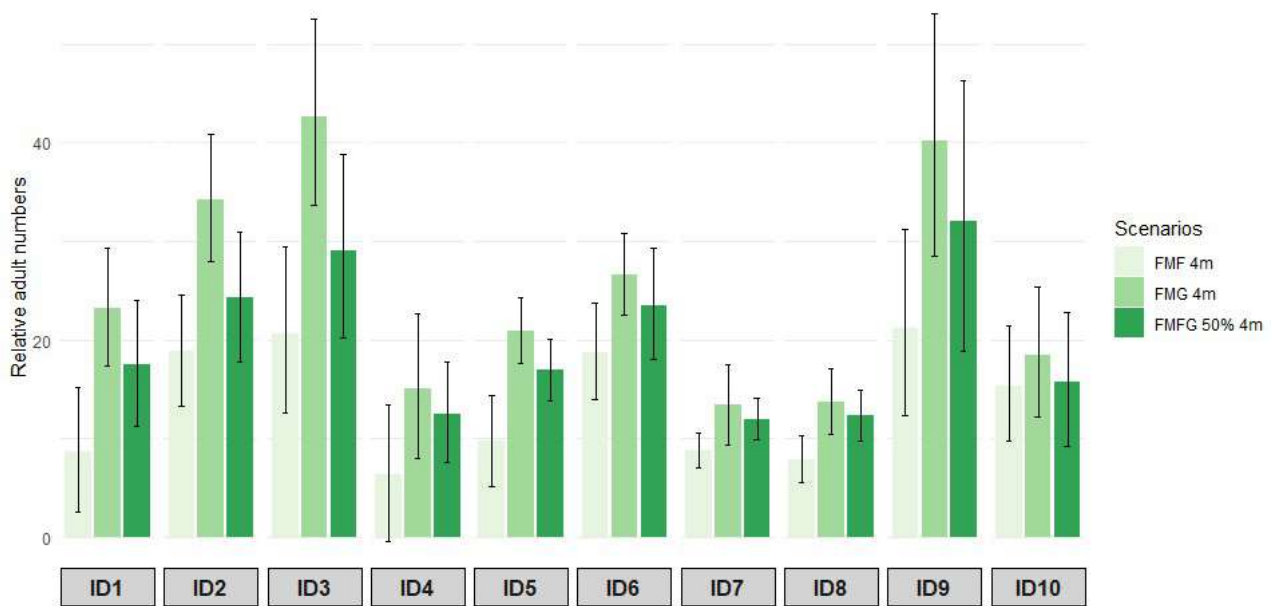


Figure 3.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

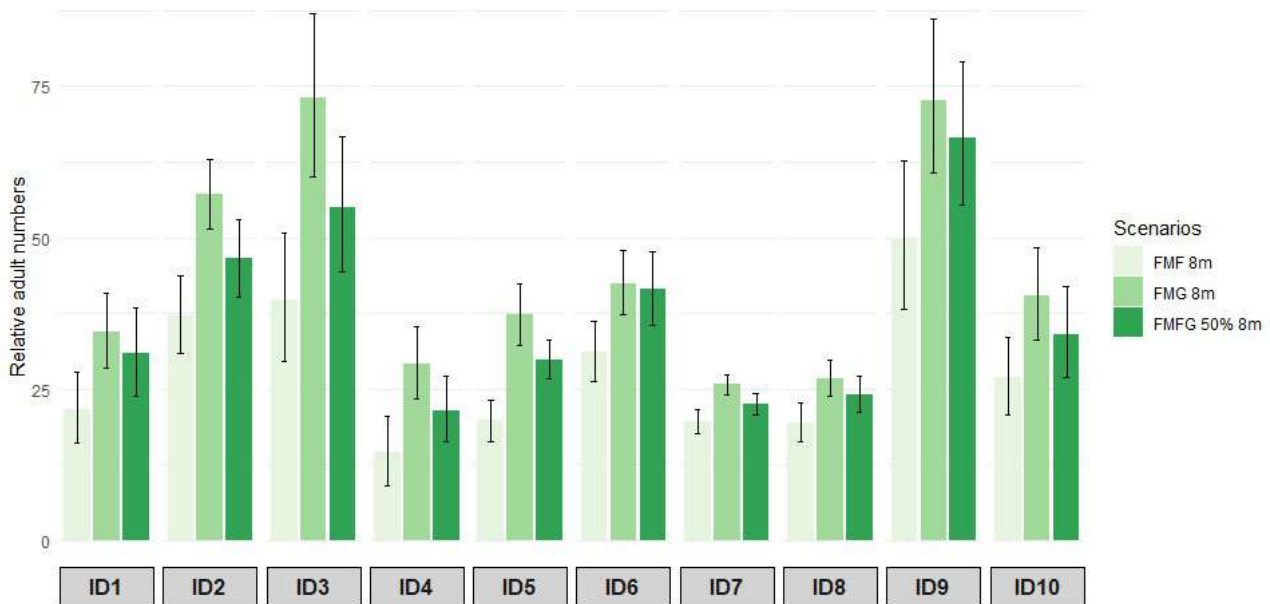


Figure 3.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

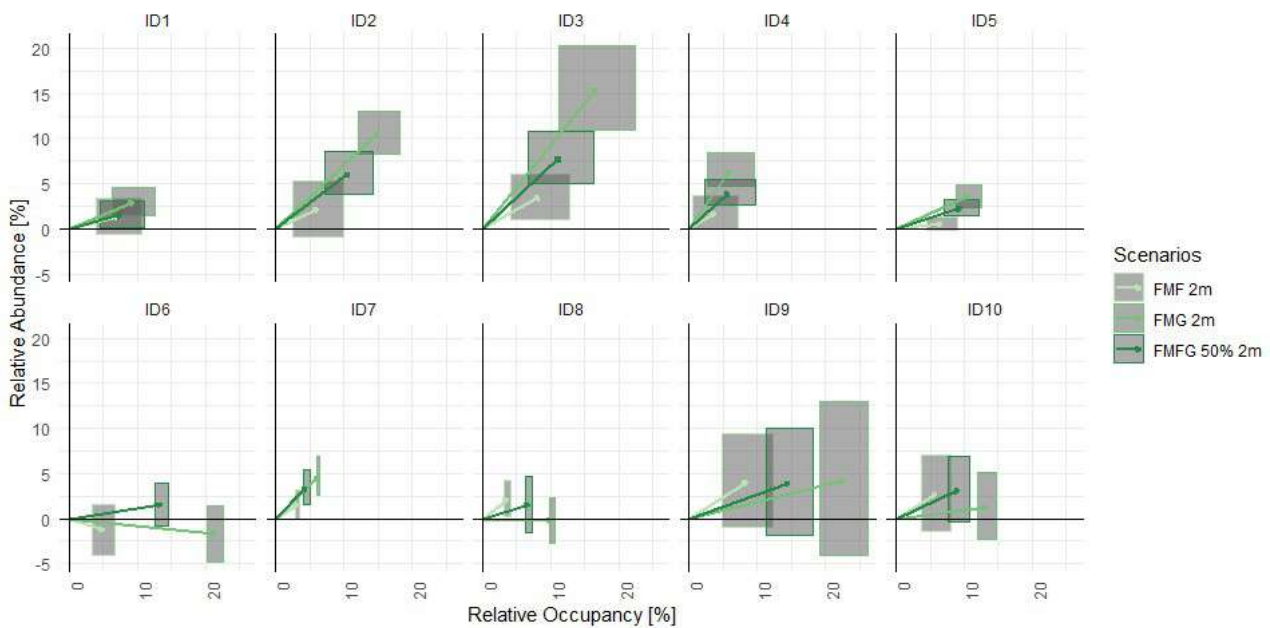


Figure 3.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

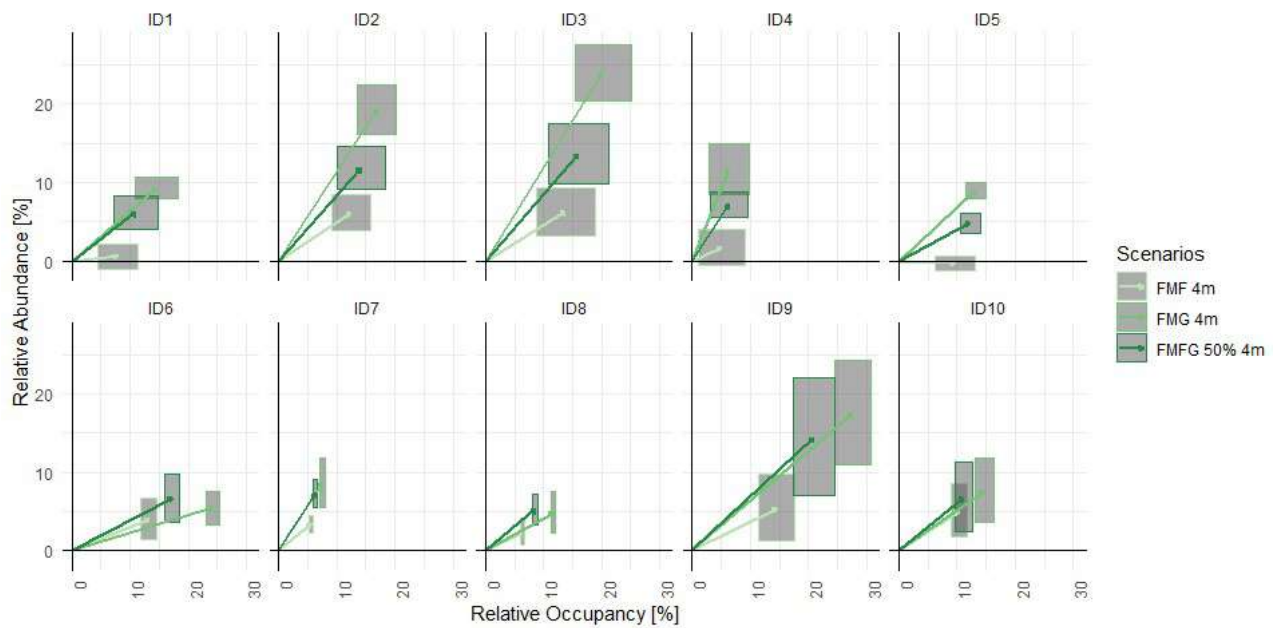


Figure 3.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes..

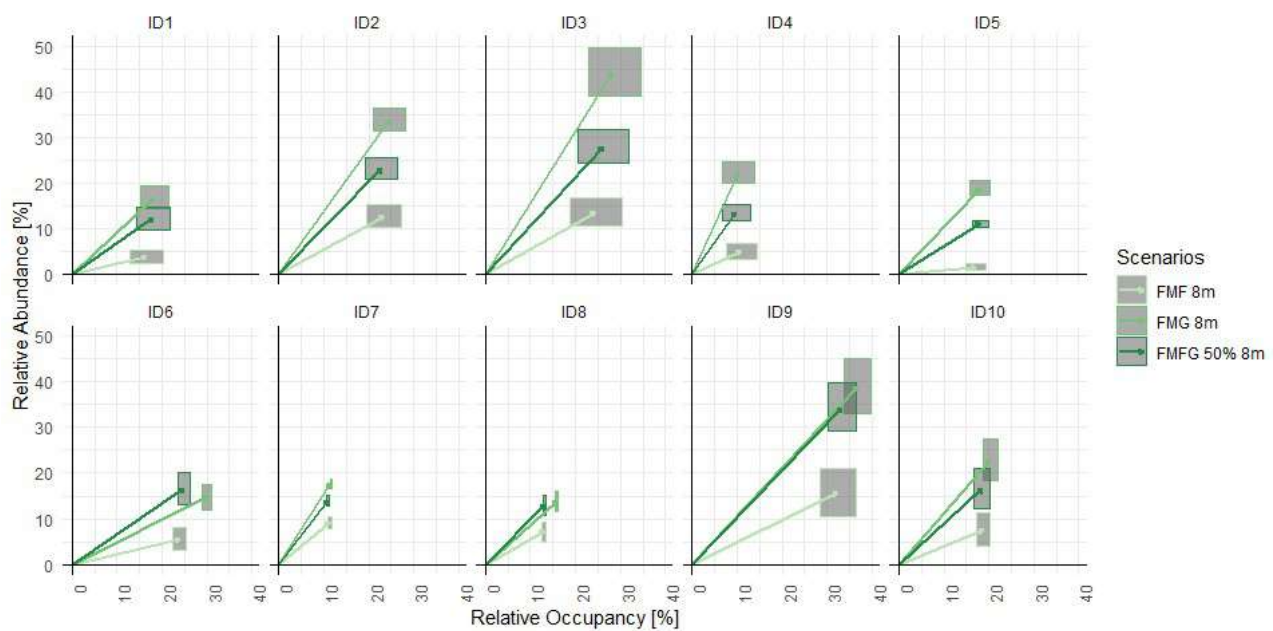


Figure 3.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.6 Setaside

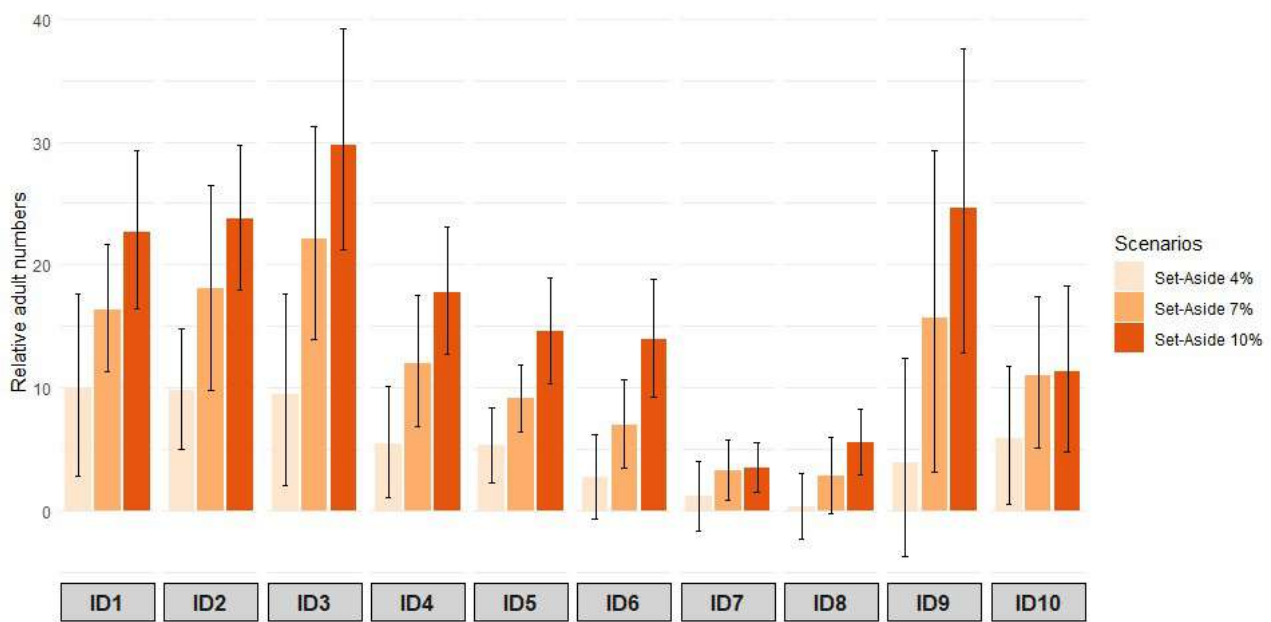


Figure 3.17 Setaside scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

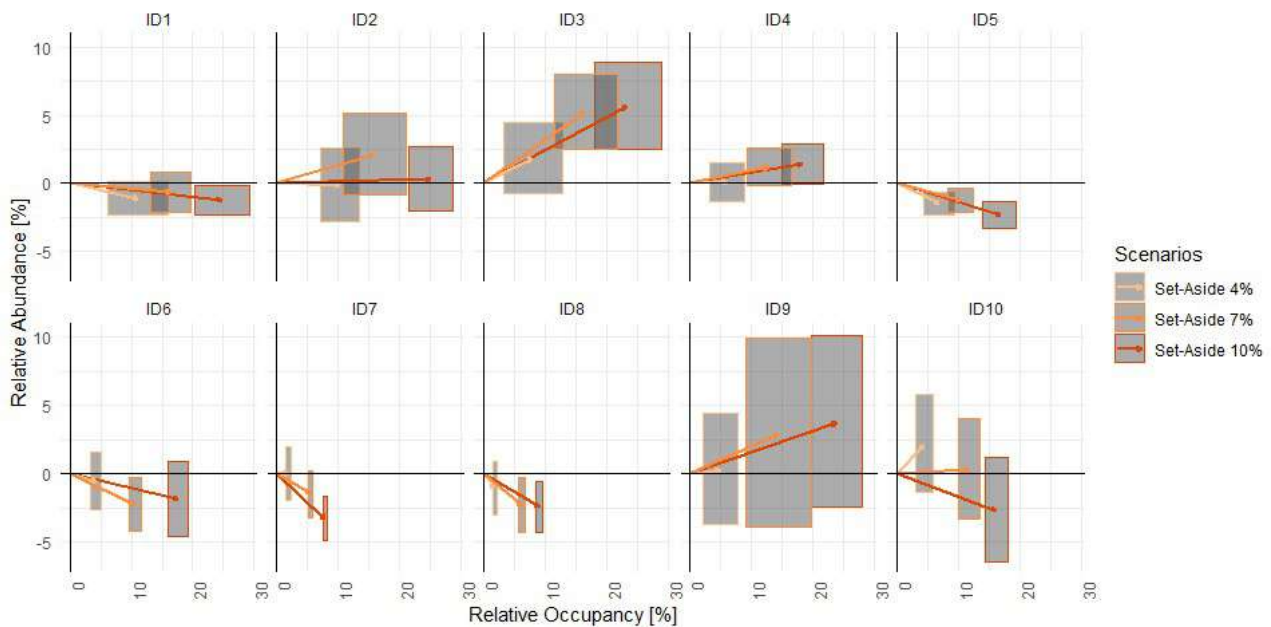


Figure 3.18 Setaside scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.7 Legume

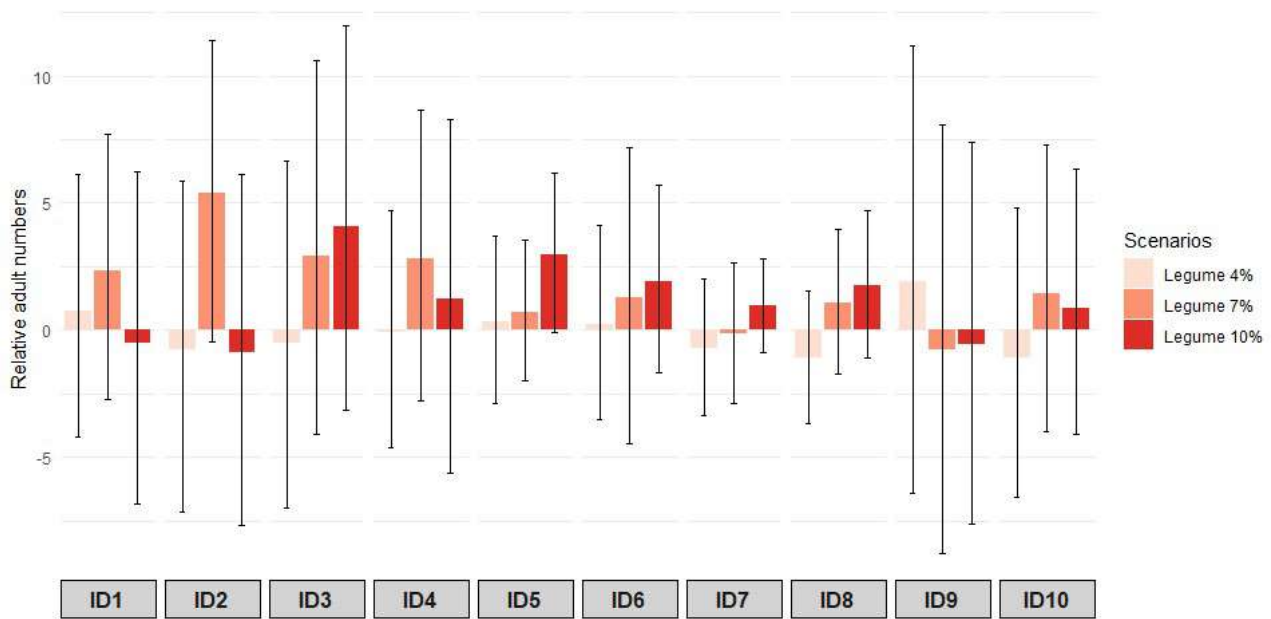


Figure 3.19 Legume scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

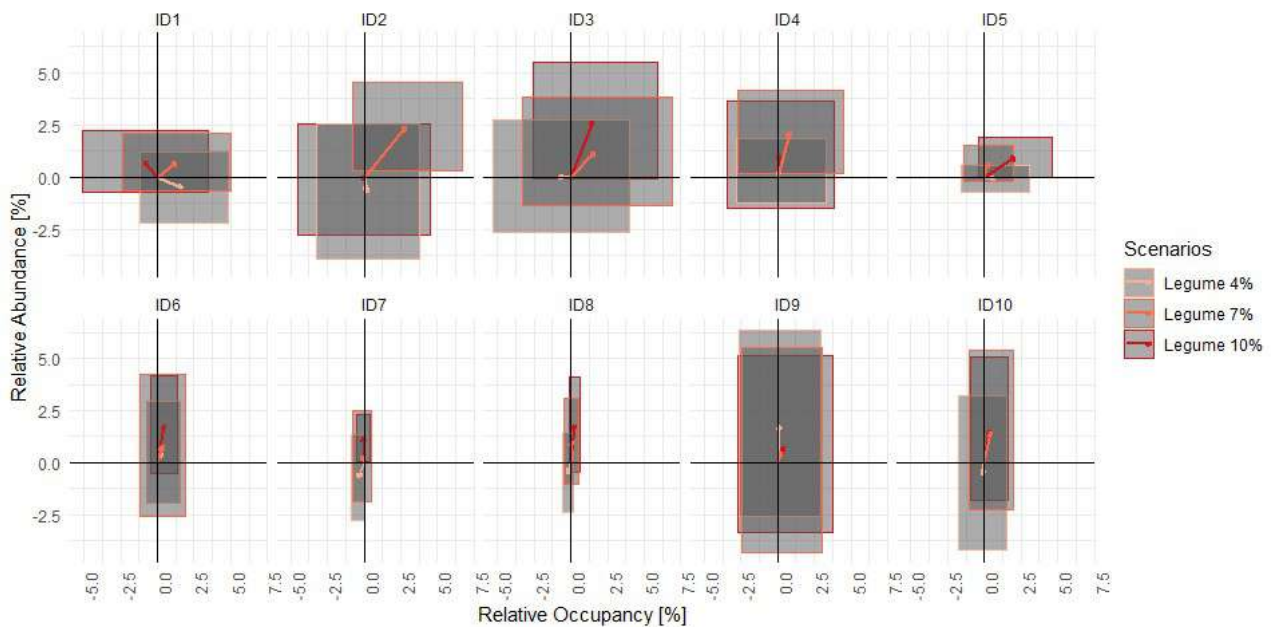


Figure 3.20 Legume scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.2.8 Biopesticides

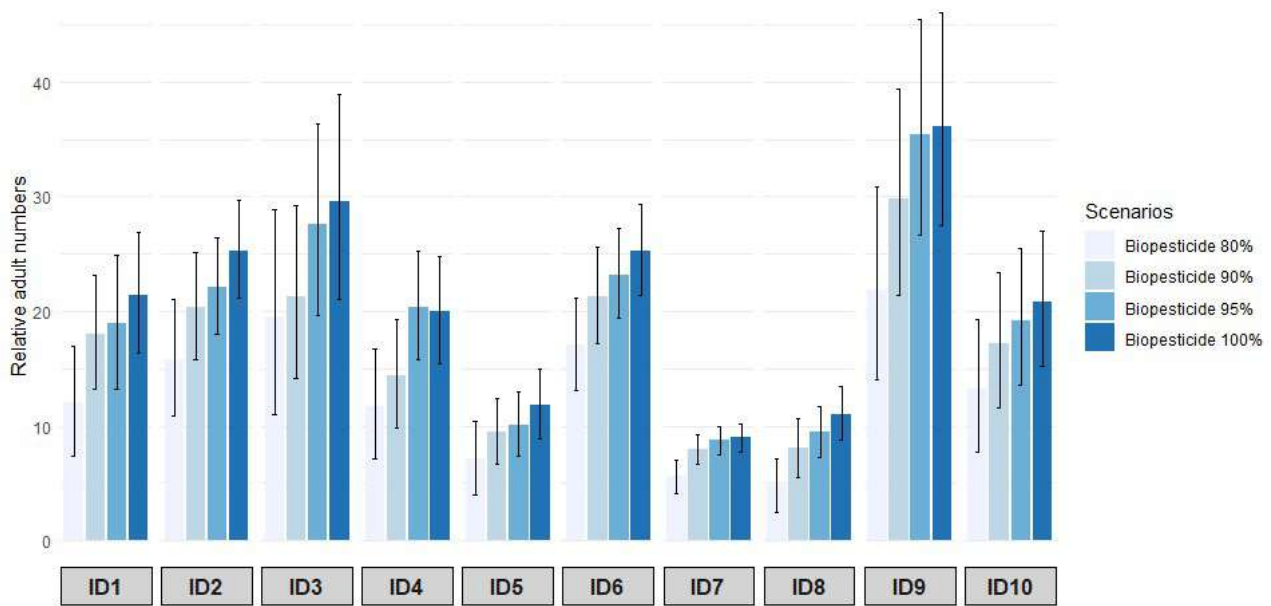


Figure 3.21 Biopesticide scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

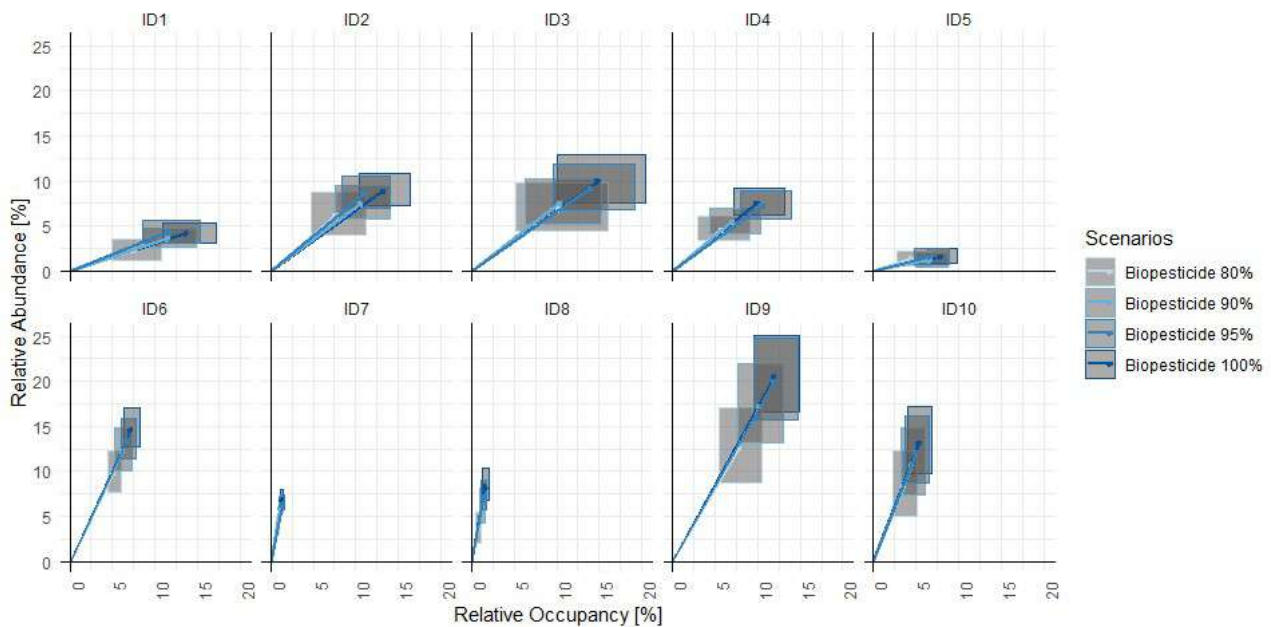


Figure 3.22 Biopesticide scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3 Denmark

3.3.1 Crop diversification

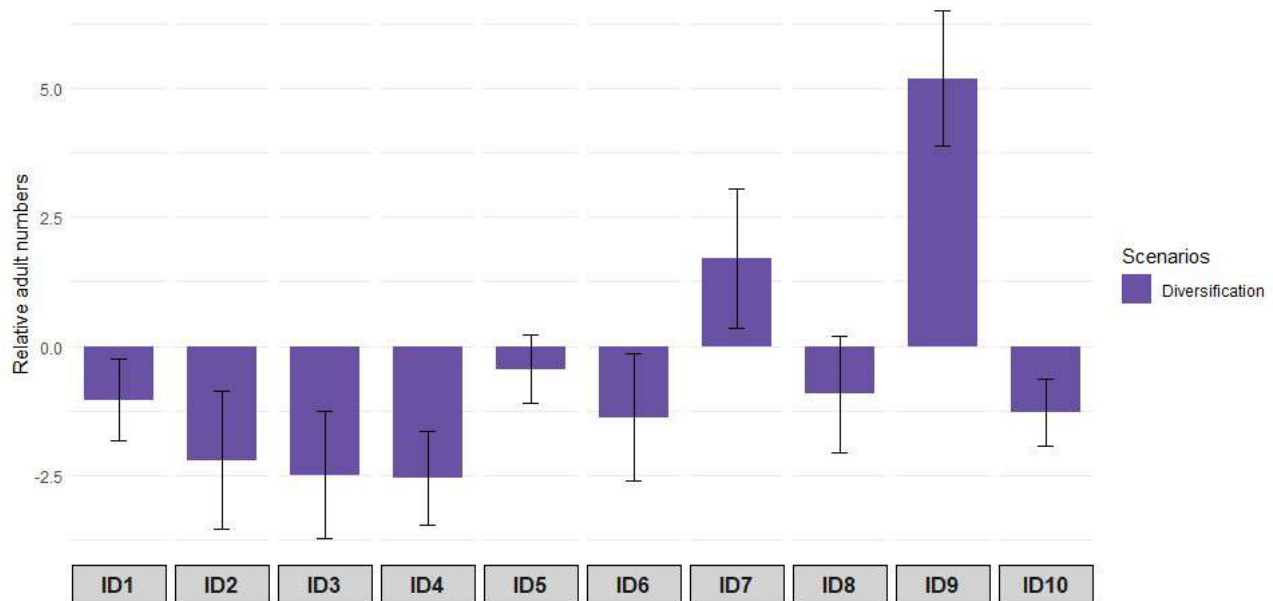


Figure 3.23 Diversification scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

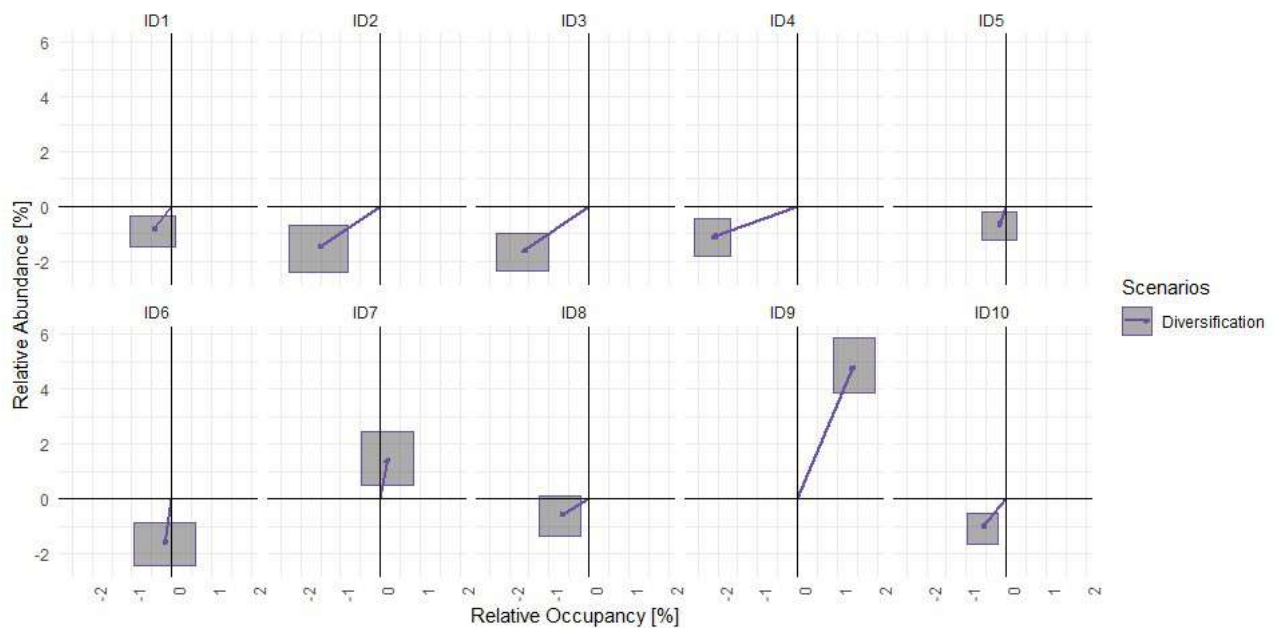


Figure 3.24 Diversification scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.2 Flower field margins

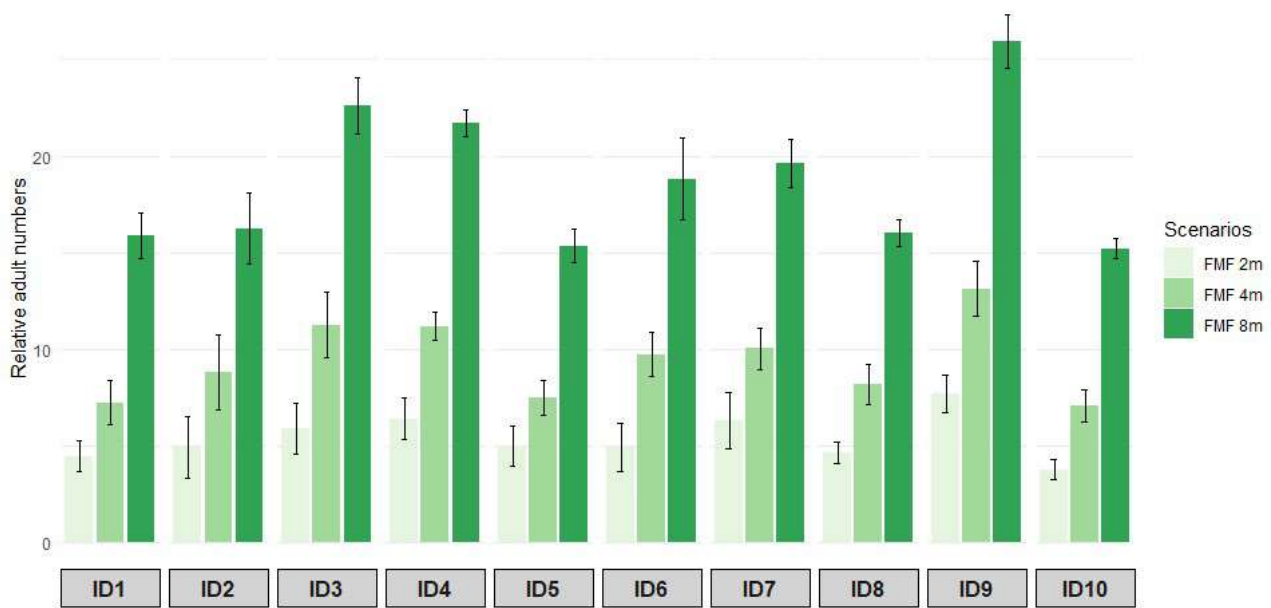


Figure 3.25 Flower field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

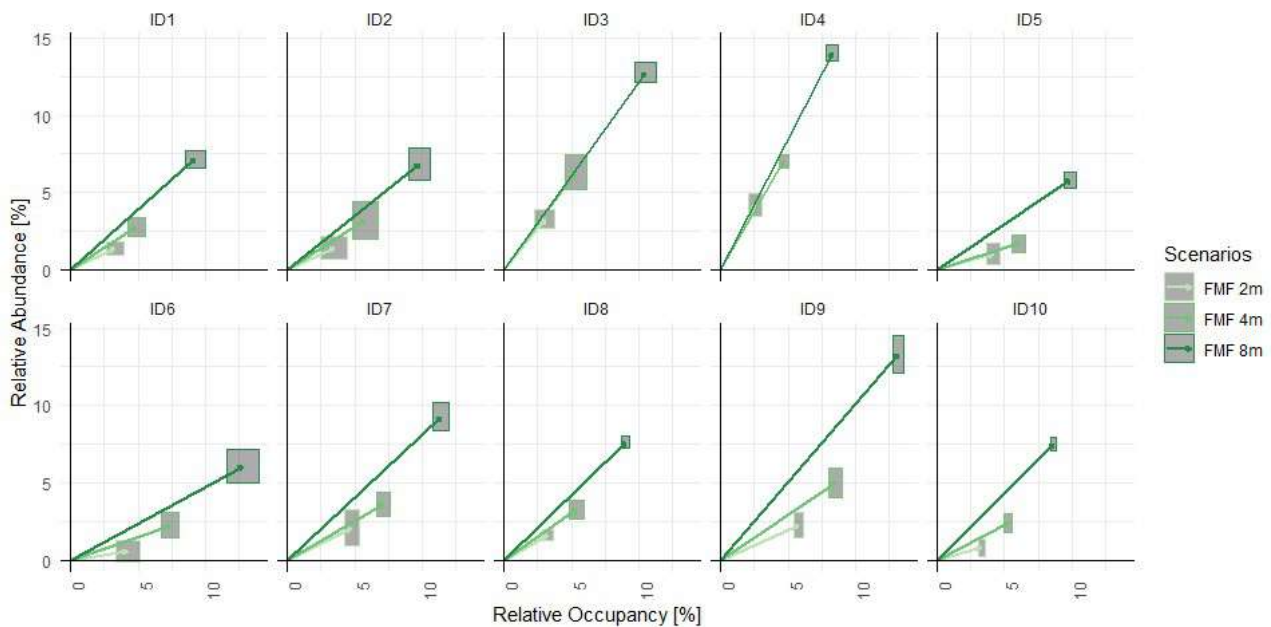


Figure 3.26 Flower field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.3 Grassy field margins

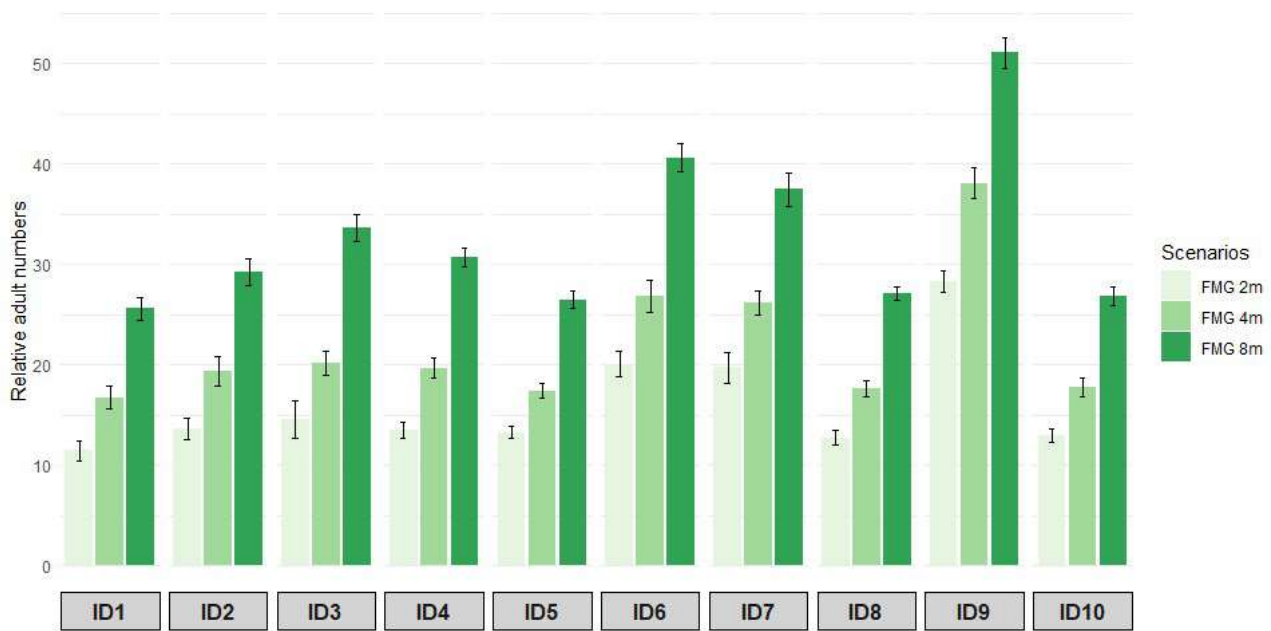


Figure 3.27 Grassy field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

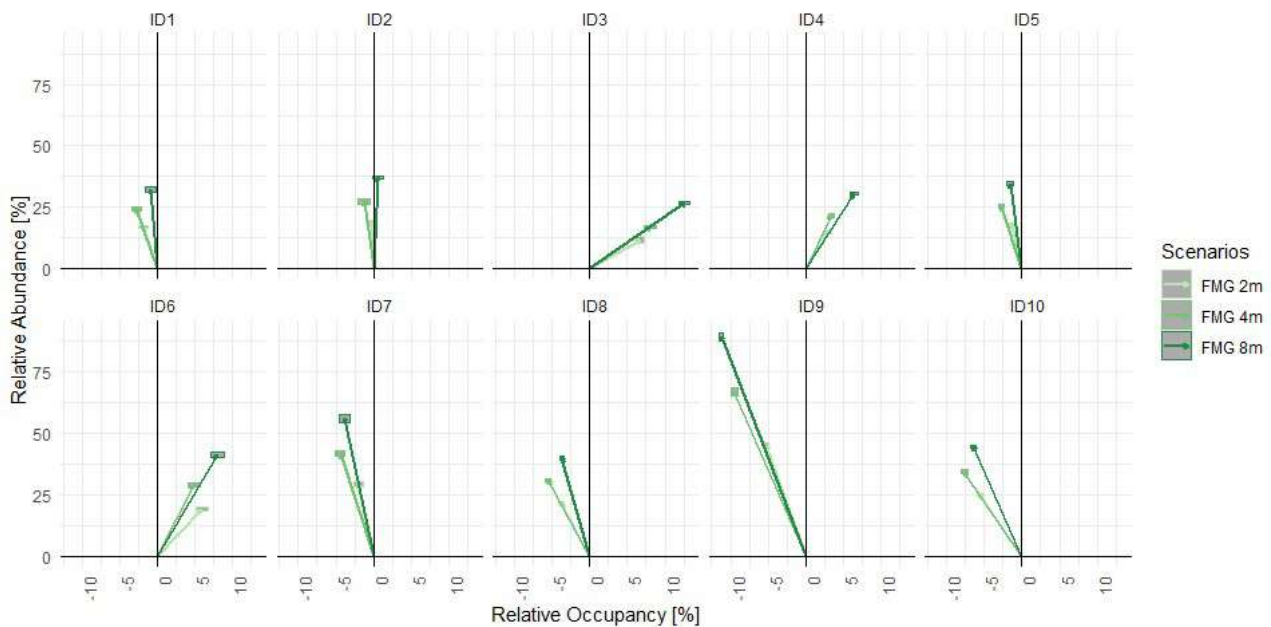


Figure 3.28 Grassy field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.4 Mixed field margins

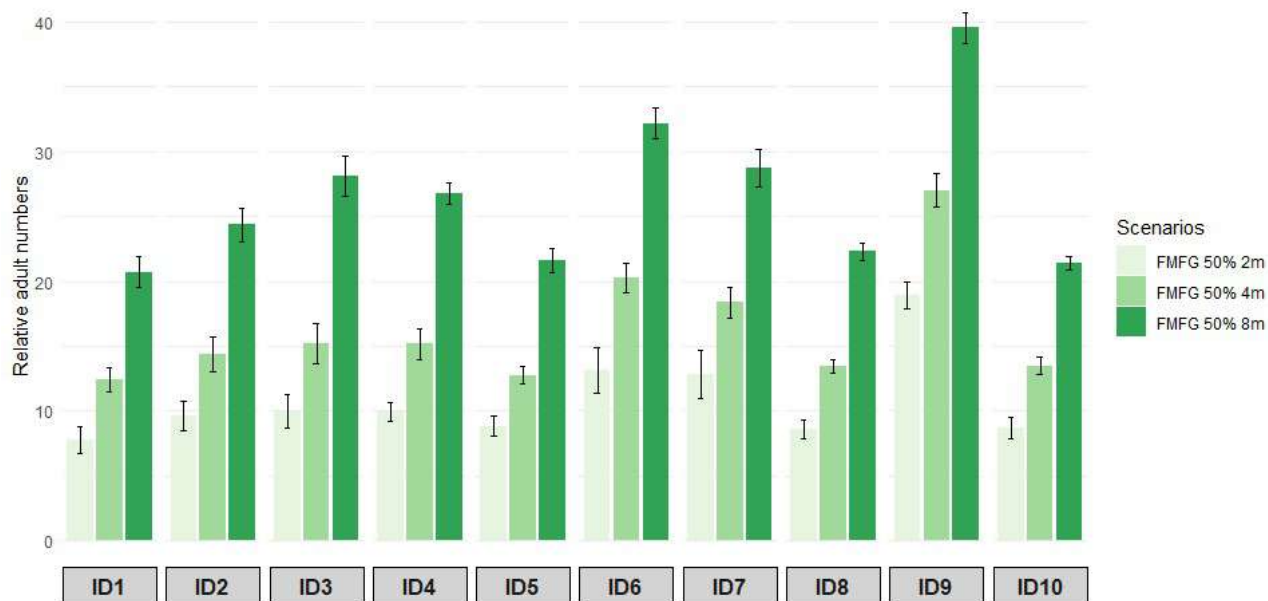


Figure 3.29 Mixed field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

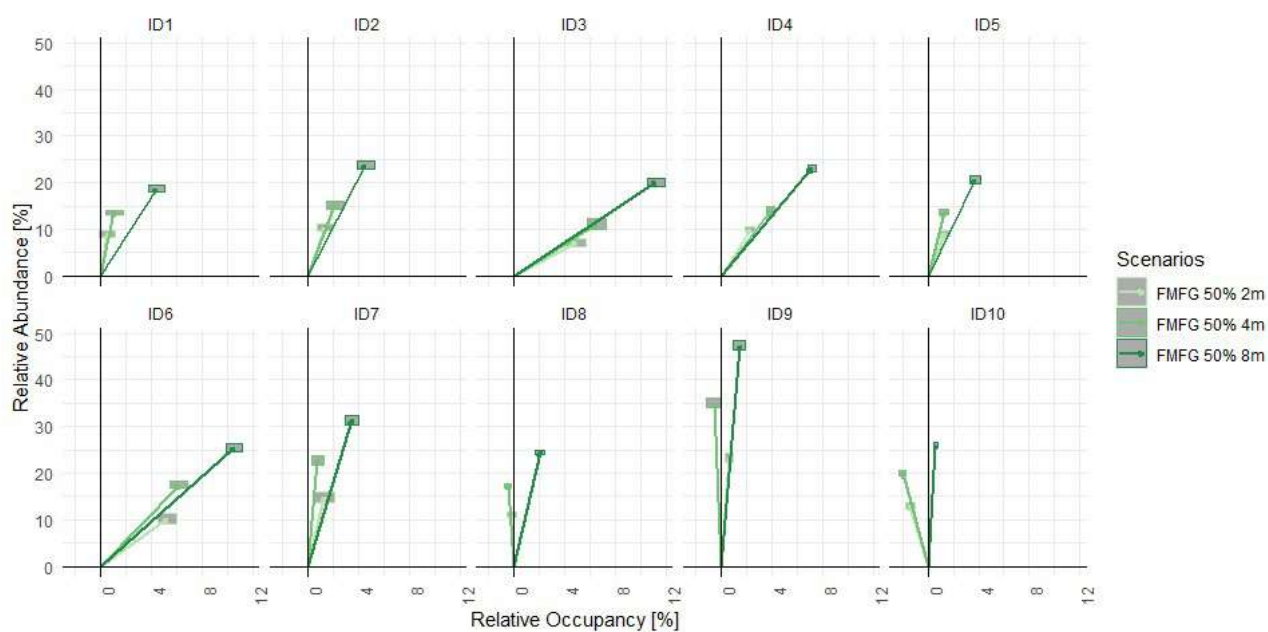


Figure 3.30 Mixed field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.5 Flower, grassy and mixed field margins

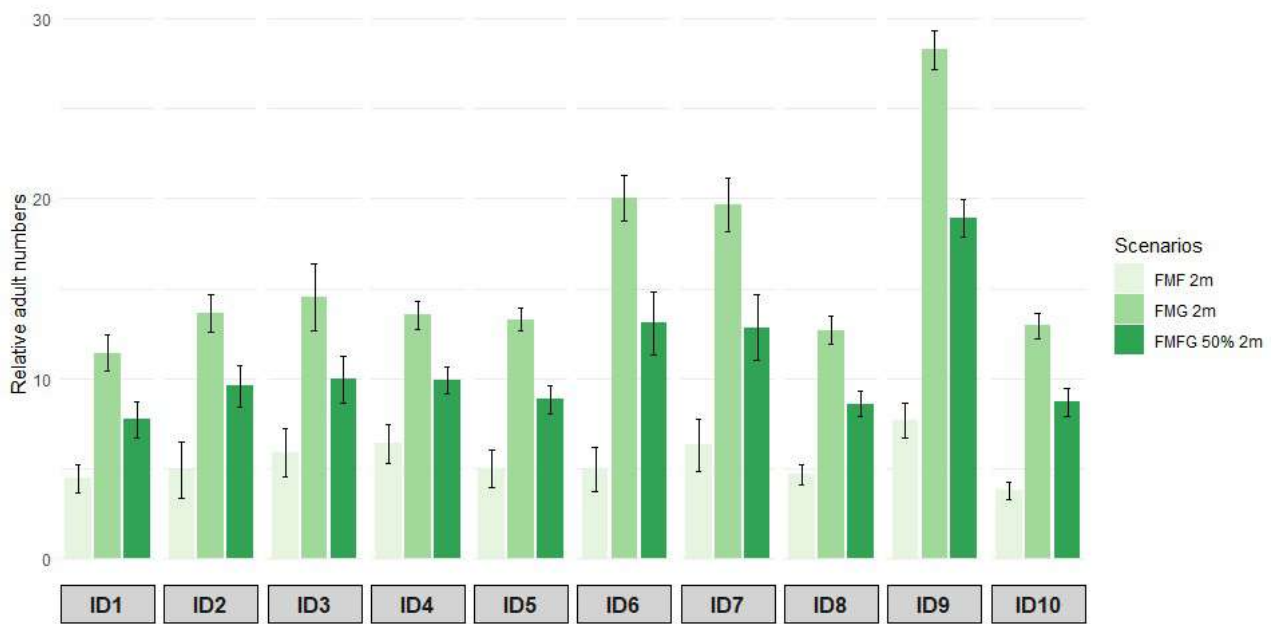


Figure 3.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

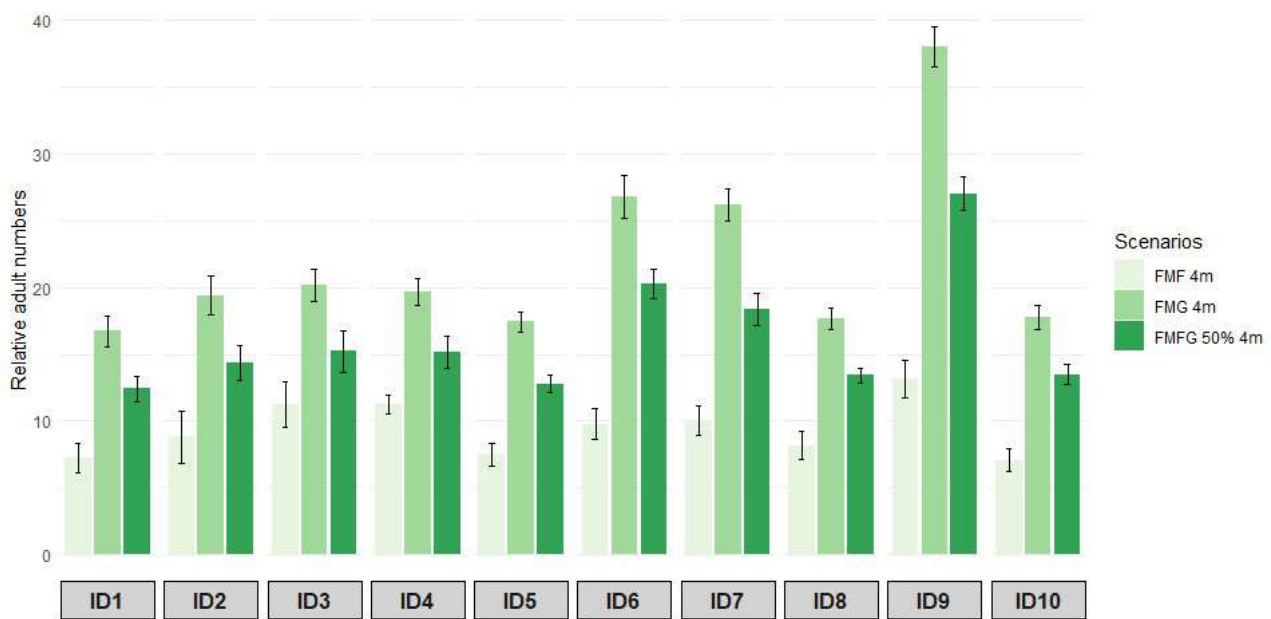


Figure 3.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

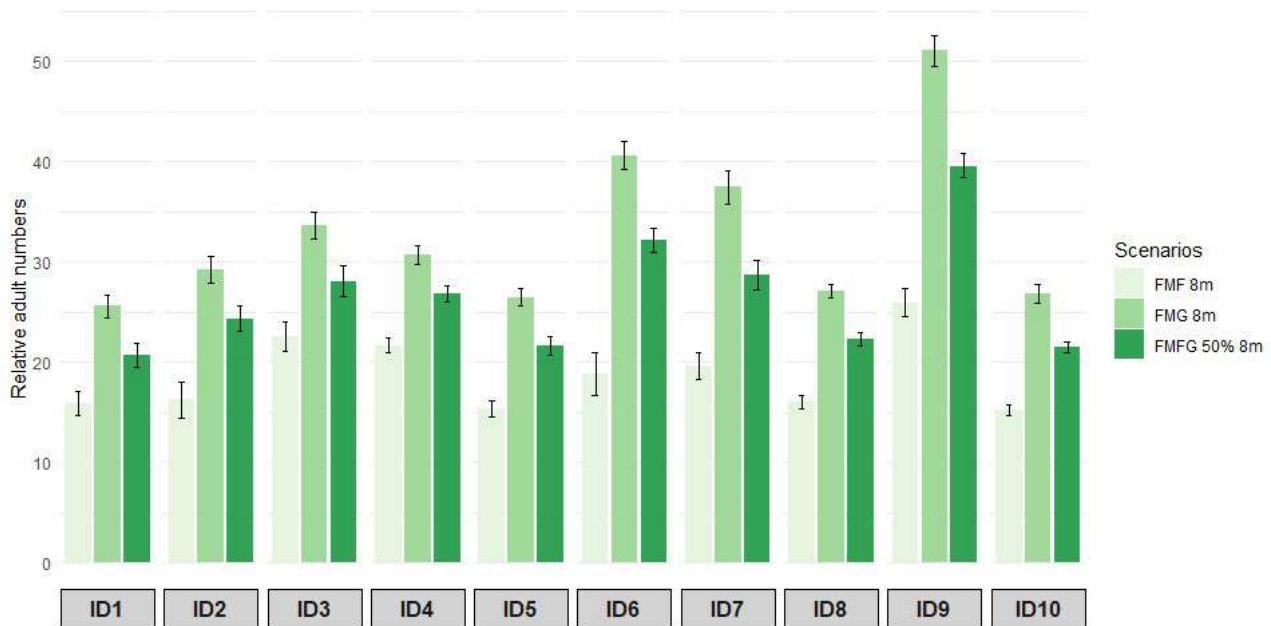


Figure 3.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

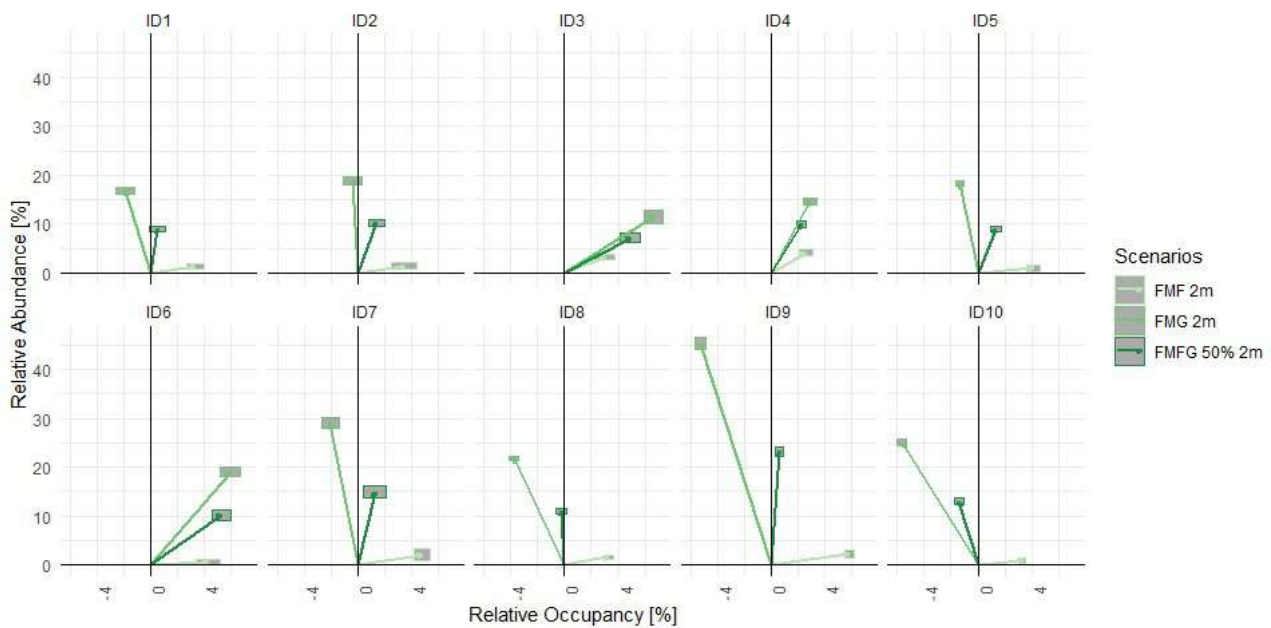


Figure 3.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

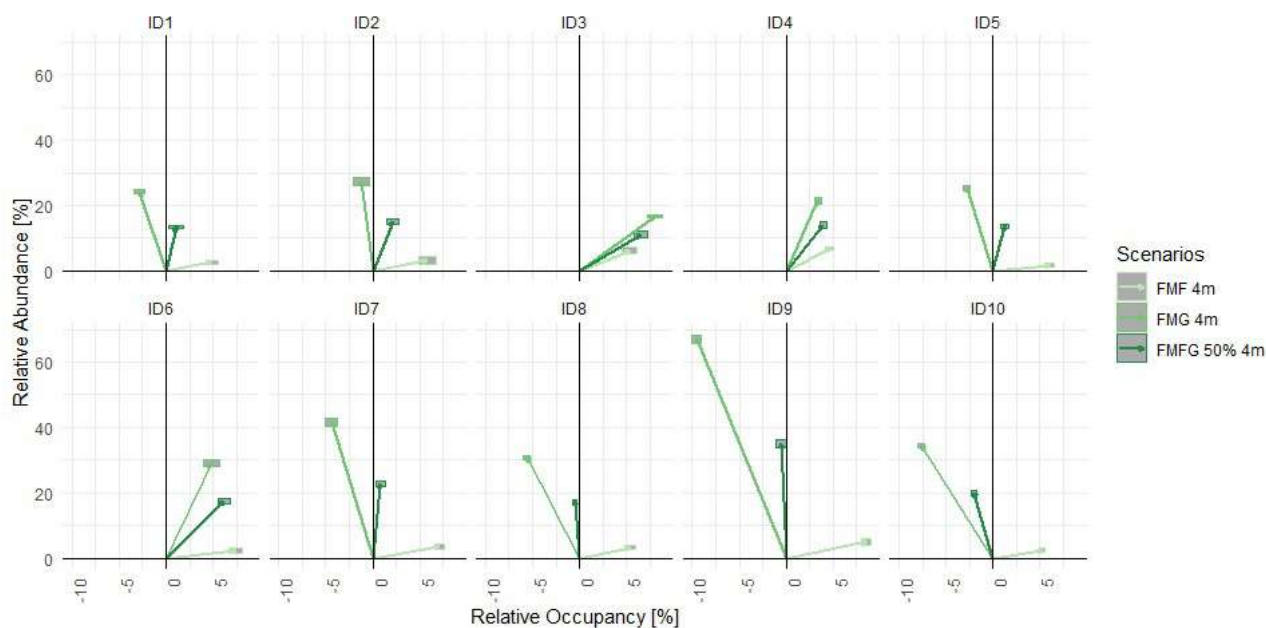


Figure 3.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes..

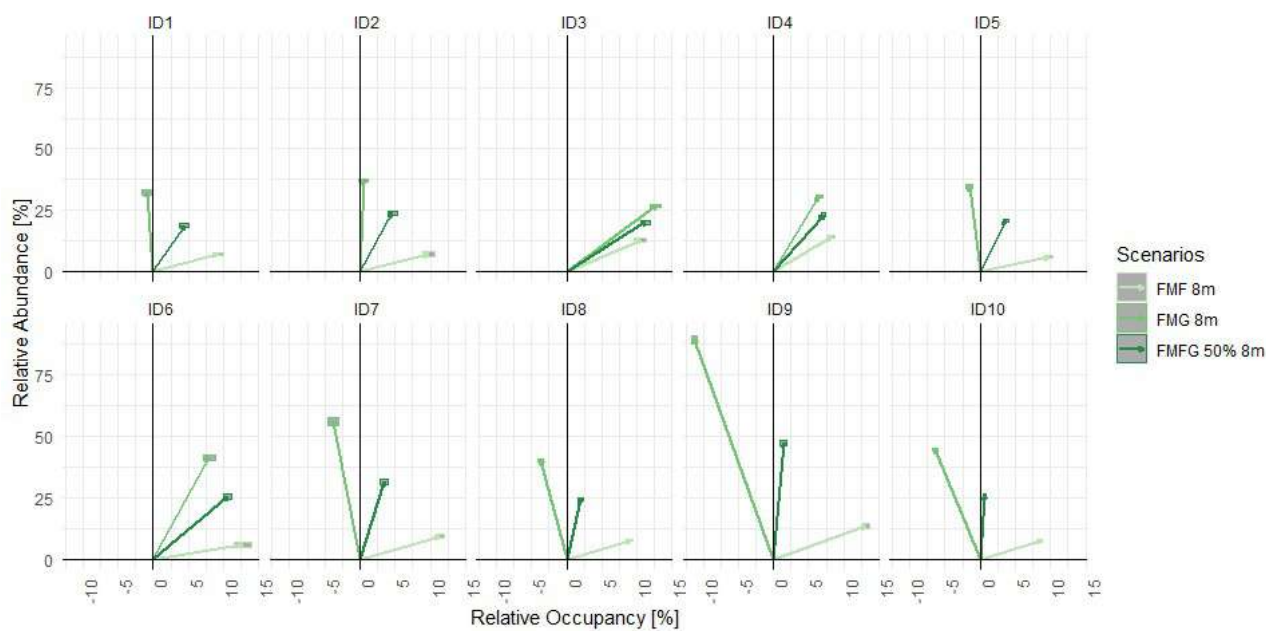


Figure 3.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.6 Setaside

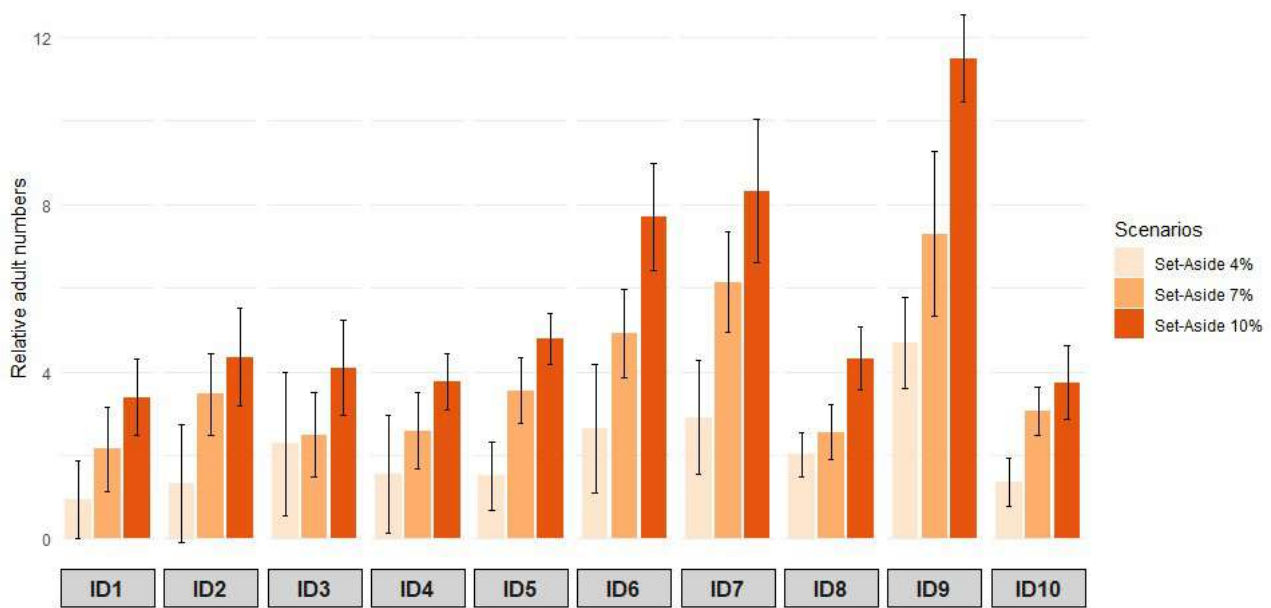


Figure 3.37 Setaside scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

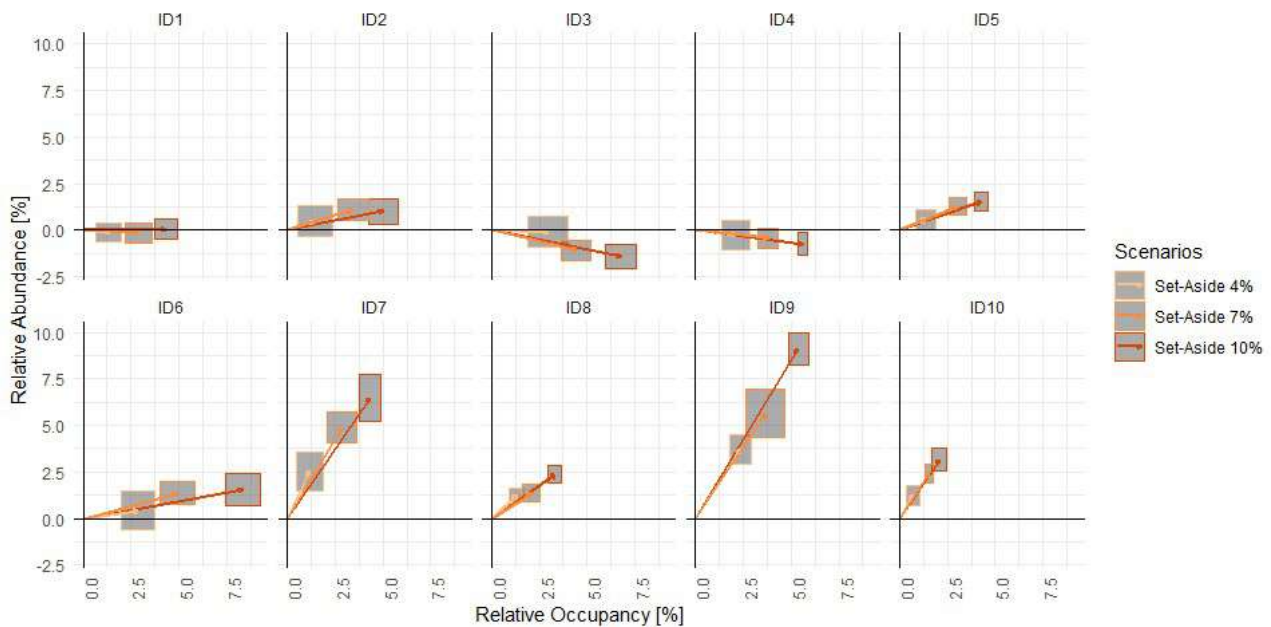


Figure 3.38 Setaside scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.7 Legume

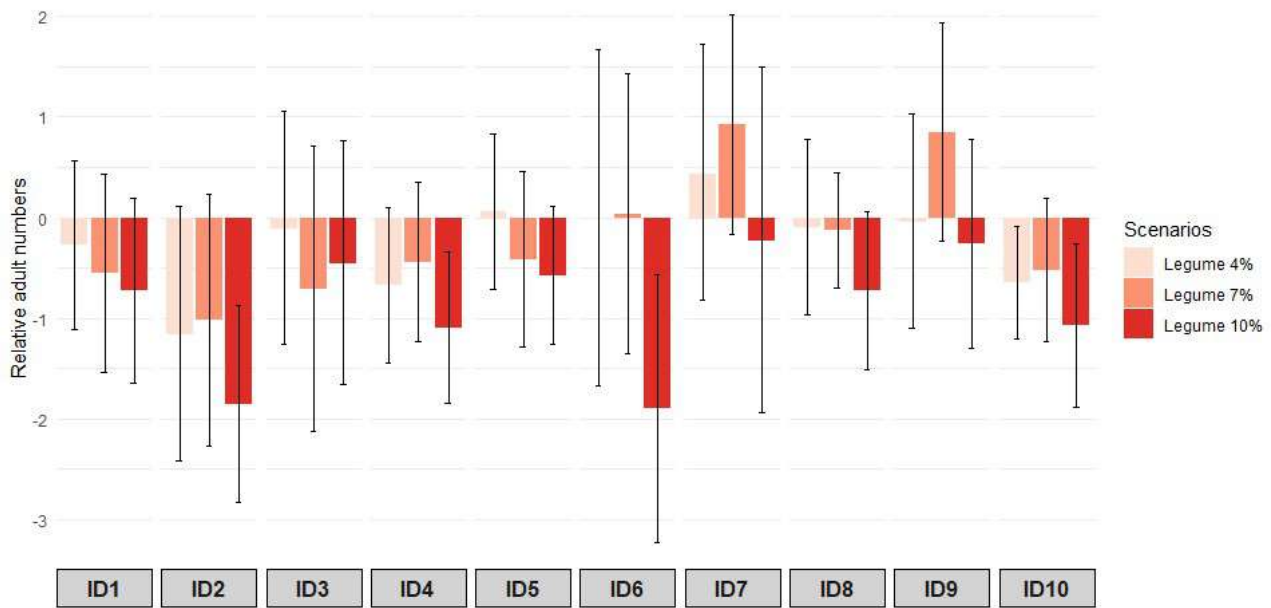


Figure 3.39 Legume scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

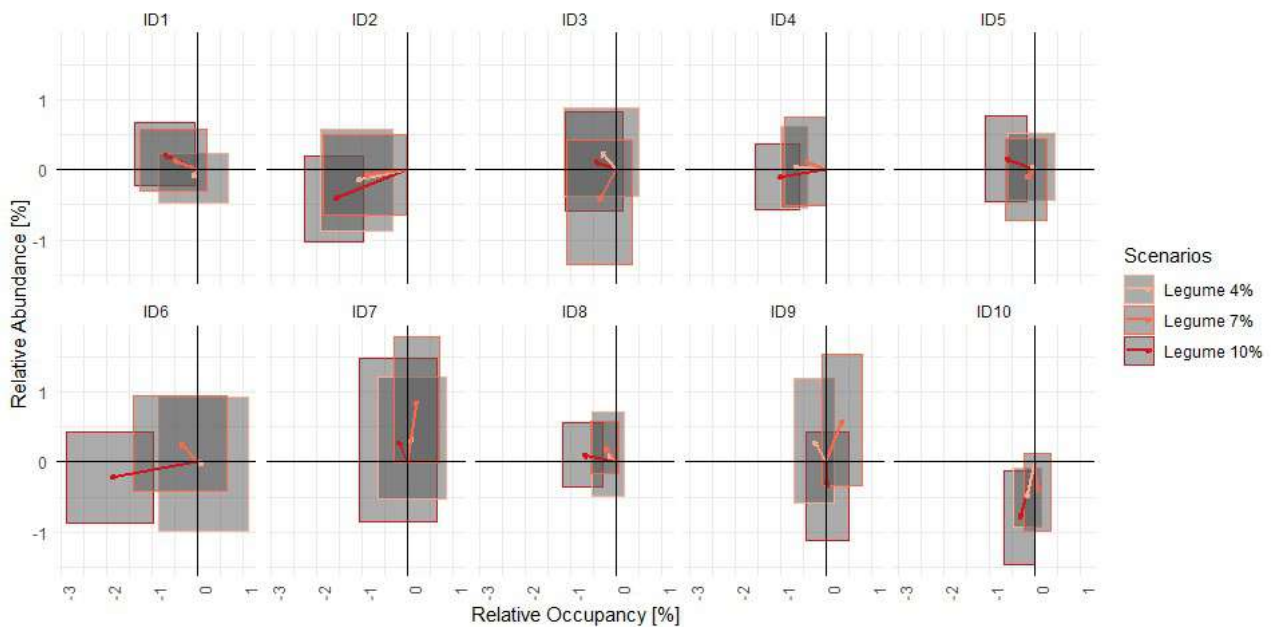


Figure 3.40 Legume scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.3.8 Biopesticides

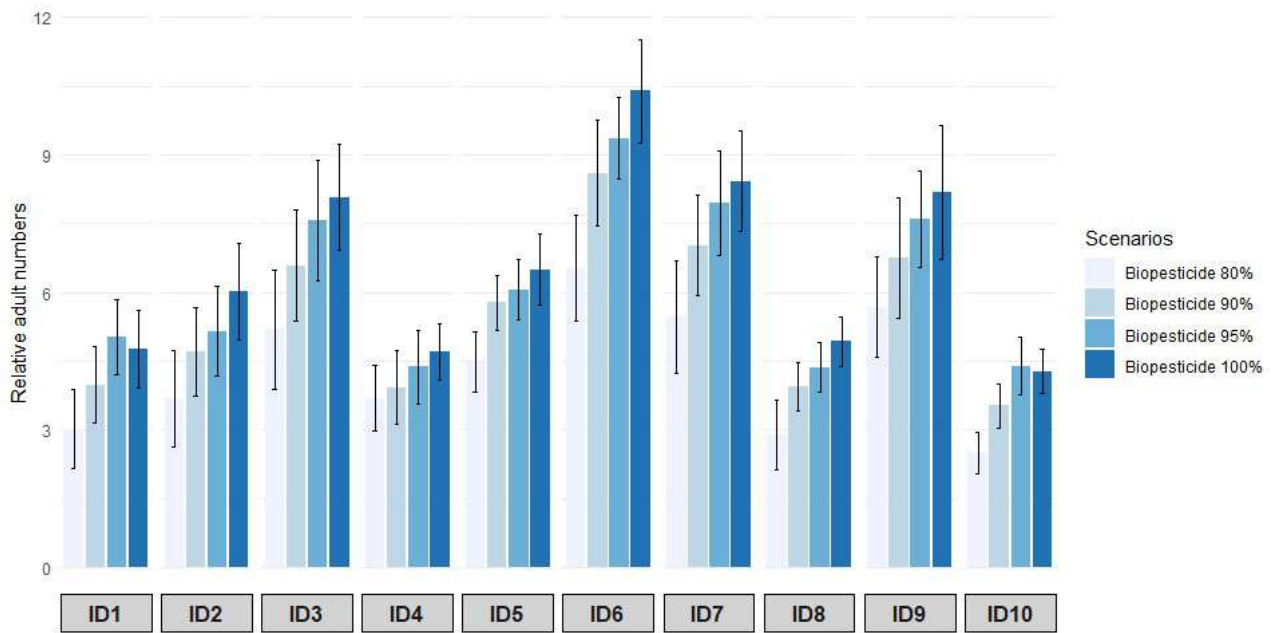


Figure 3.41 Biopesticide scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

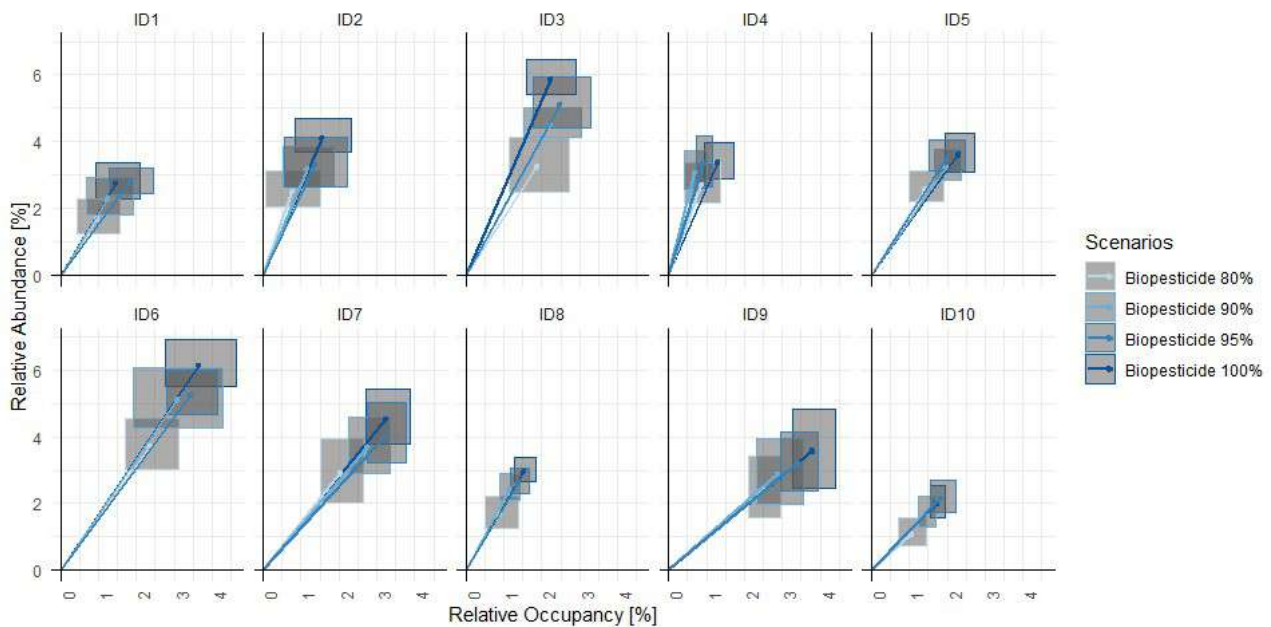


Figure 3.42 Biopesticide scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4 Poland

3.4.1 Flower field margins

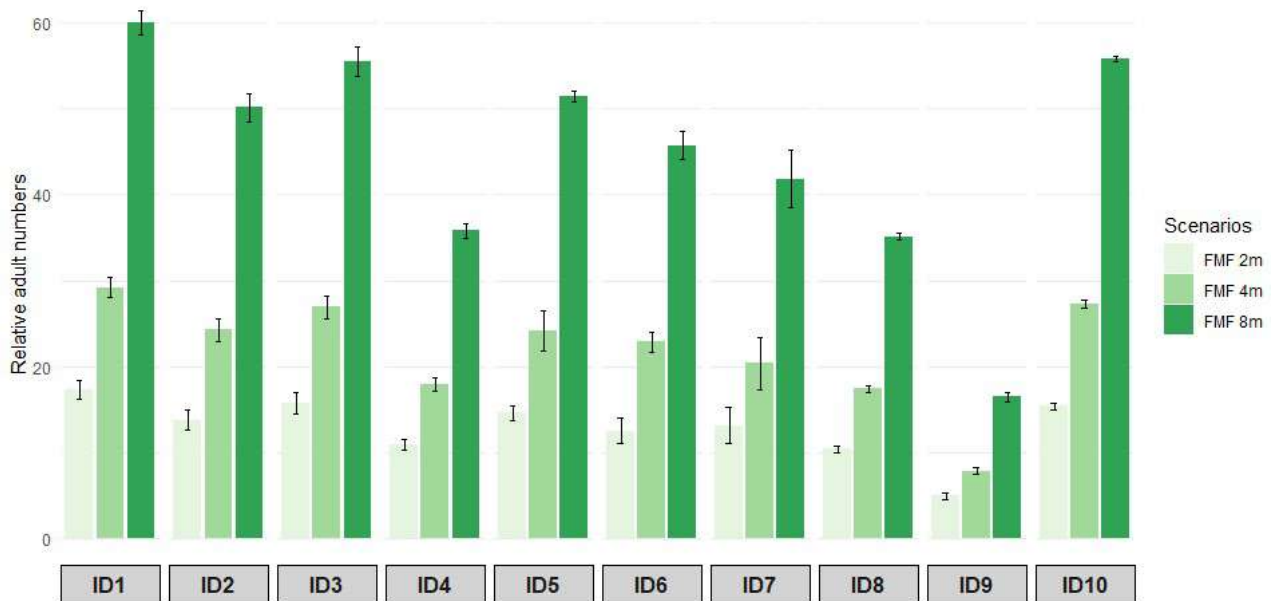


Figure 3.43 Flower field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

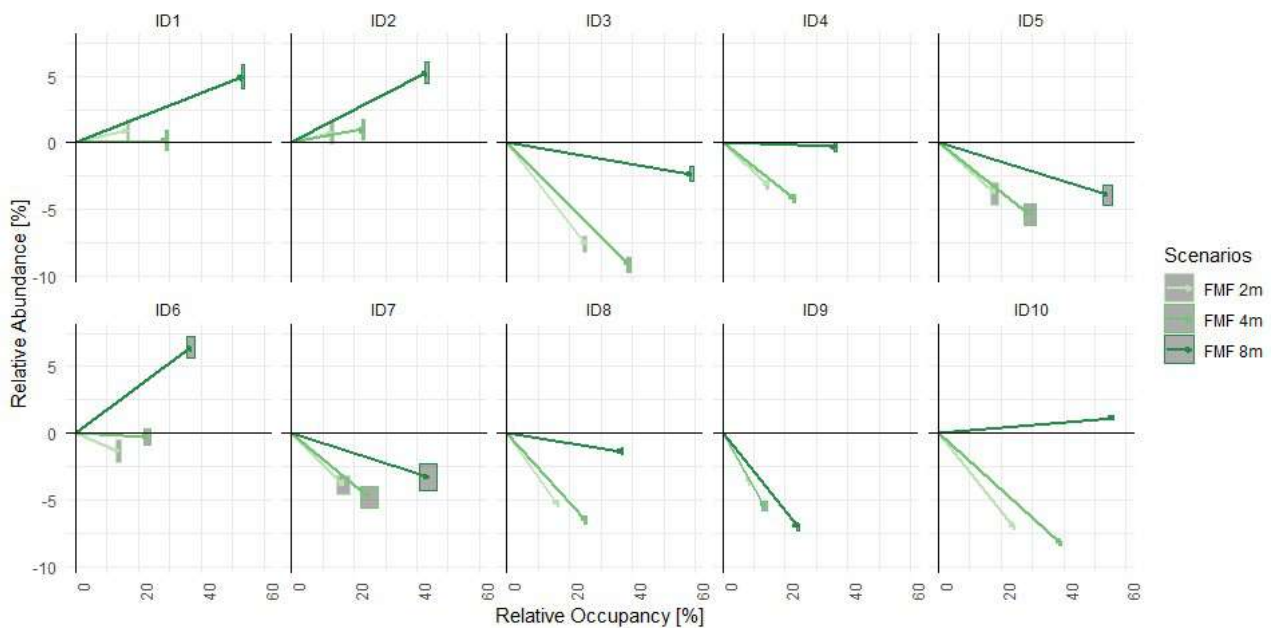


Figure 3.44 Flower field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4.2 Grassy field margins

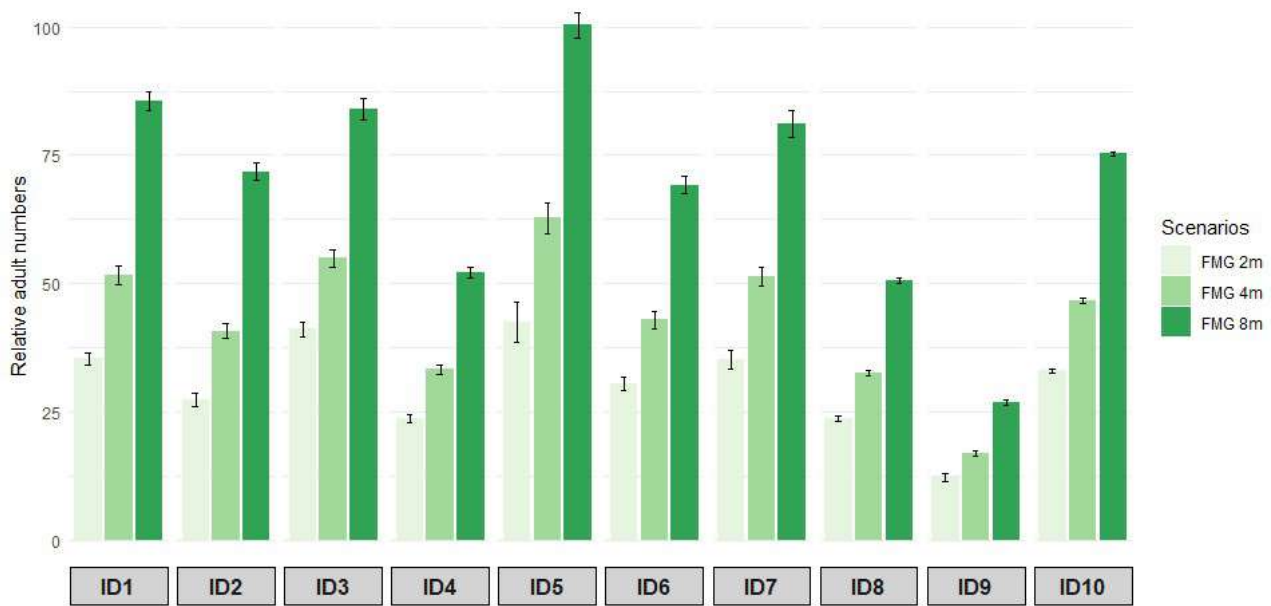


Figure 3.45 Grassy field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

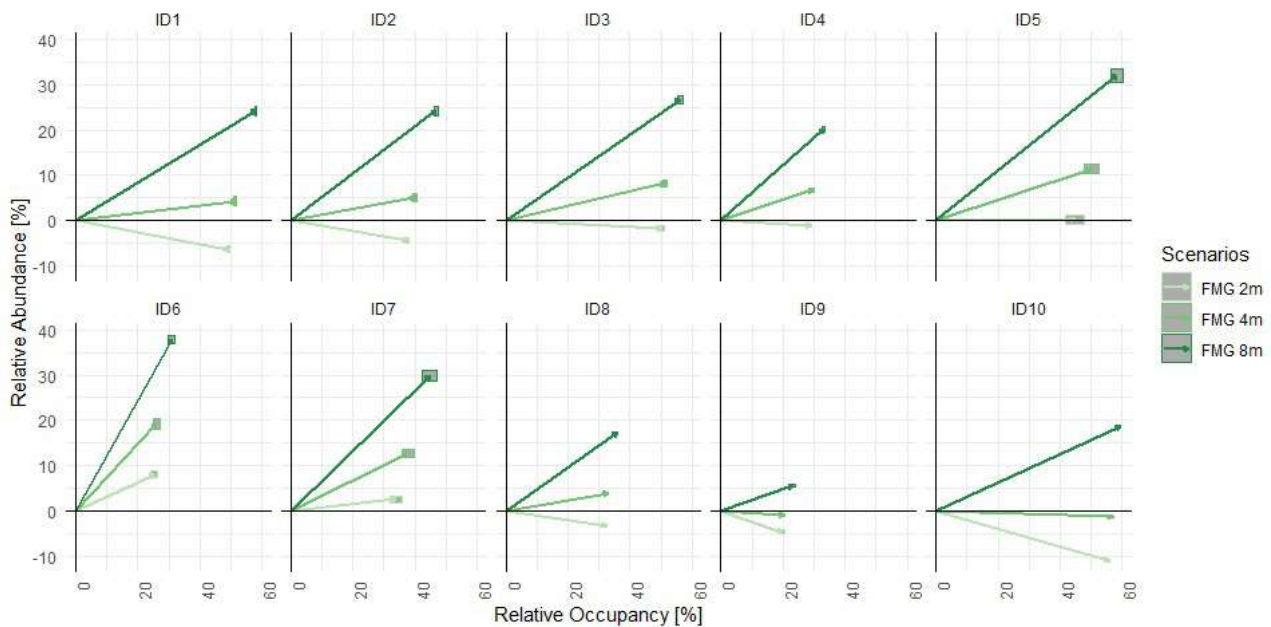


Figure 3.46 Grassy field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4.3 Mixed field margins

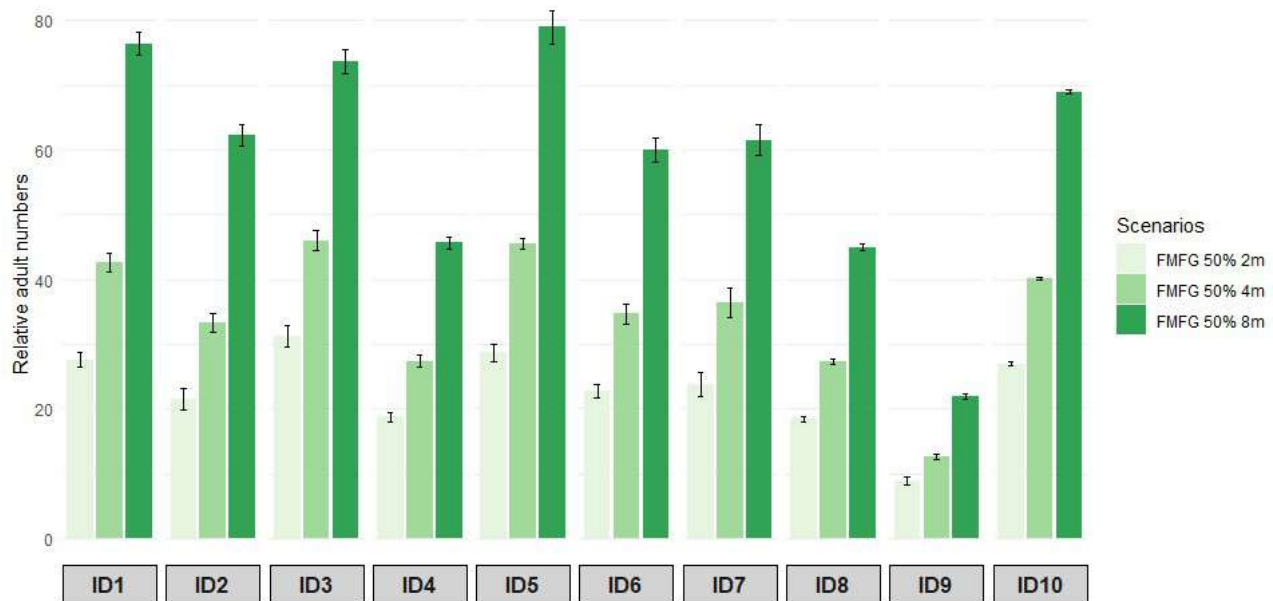


Figure 3.47 Mixed field margins scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

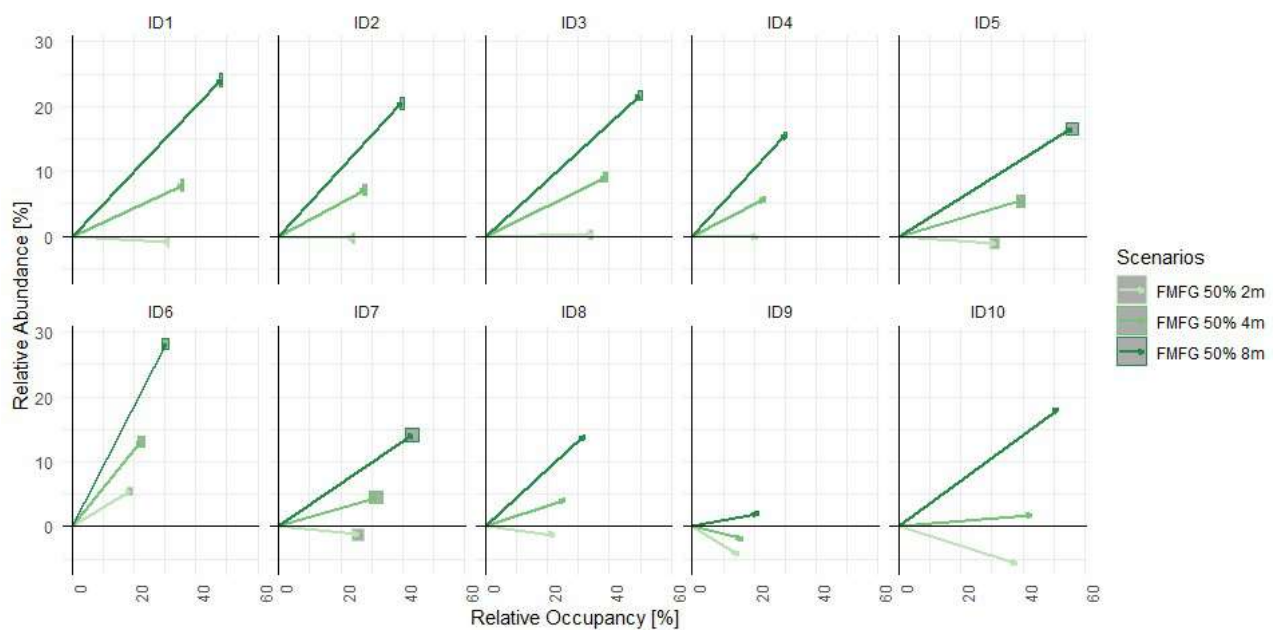


Figure 3.48 Mixed field margins with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4.4 Flower, grassy and mixed field margins

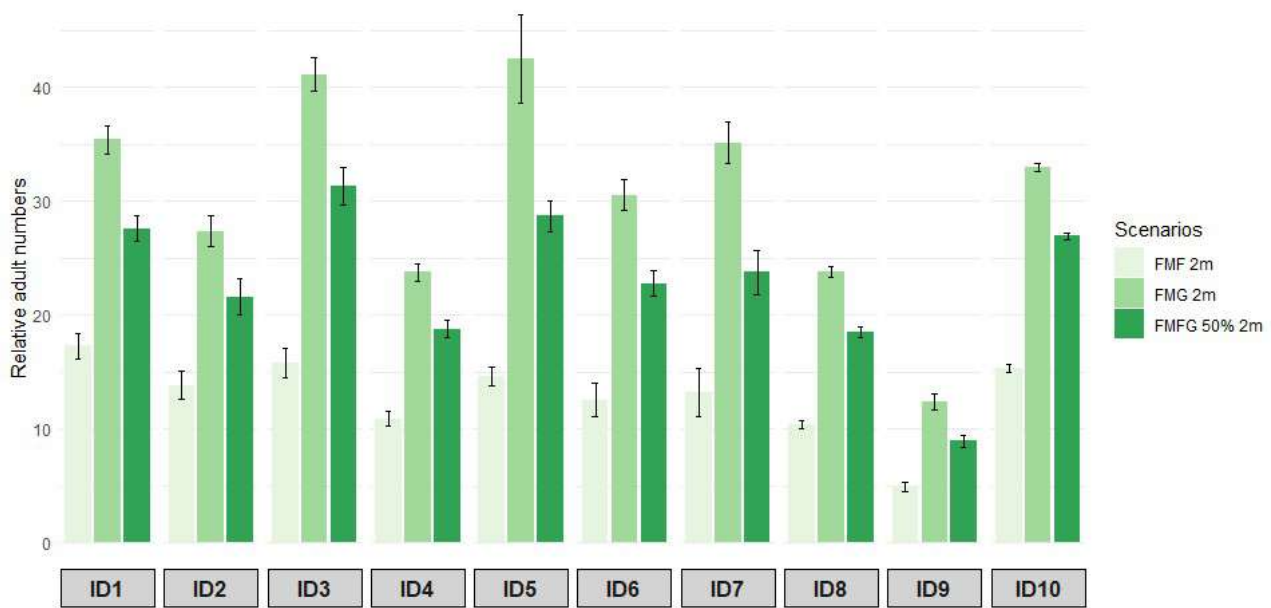


Figure 3.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.



Figure 3.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

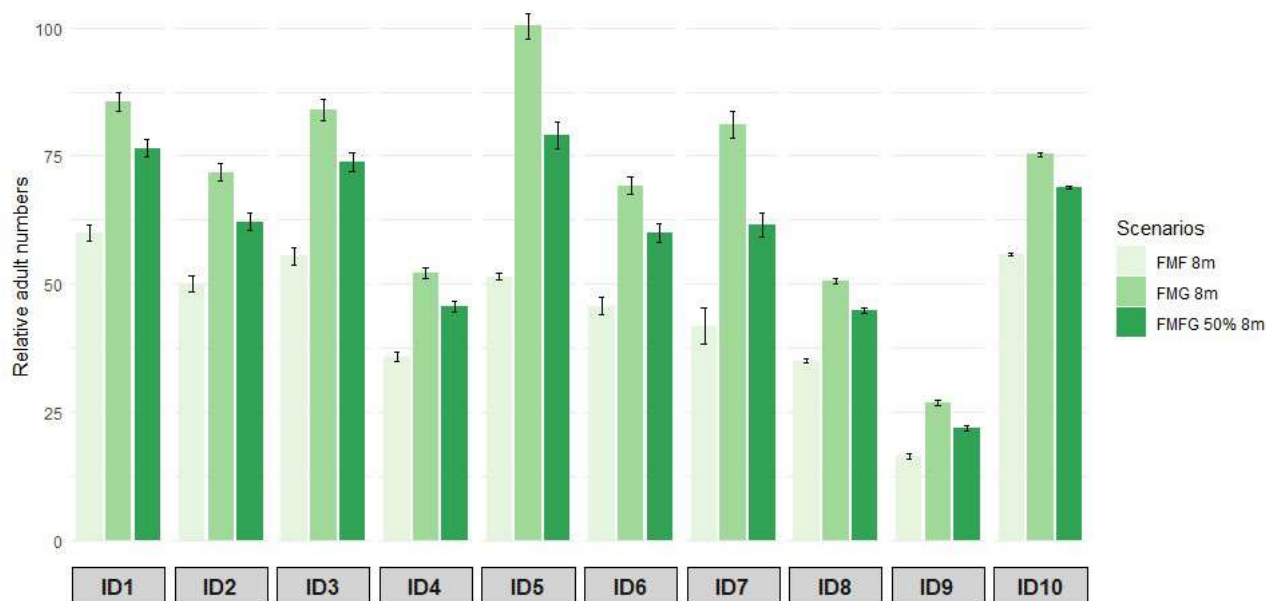


Figure 3.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

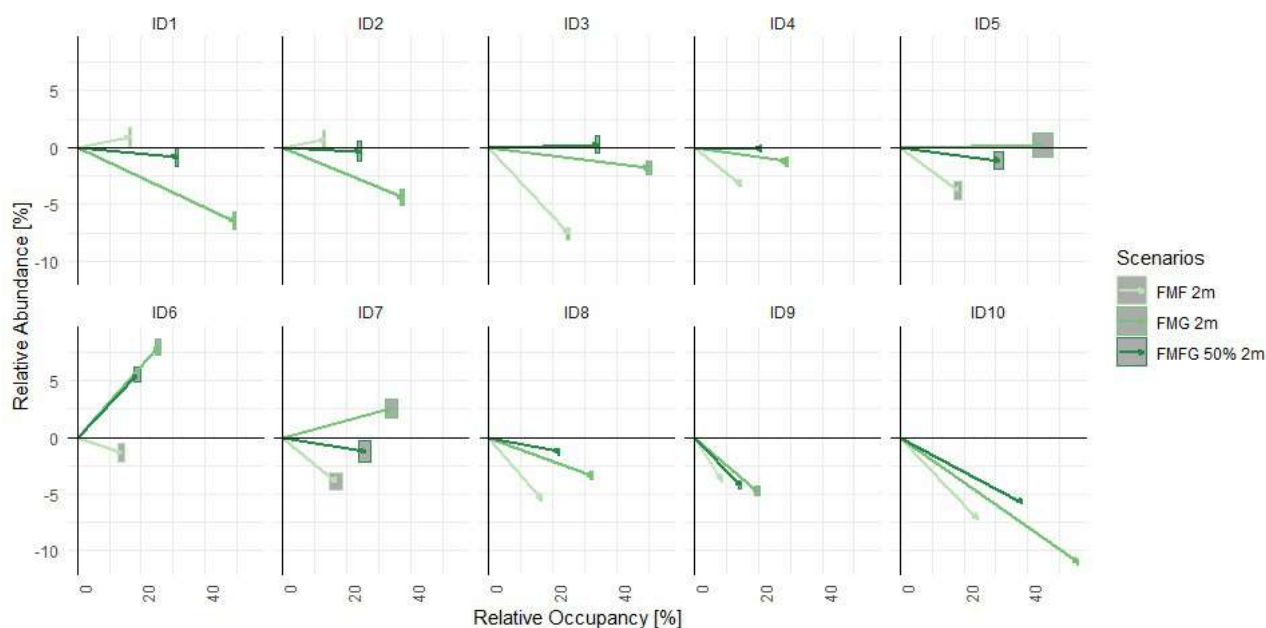


Figure 3.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

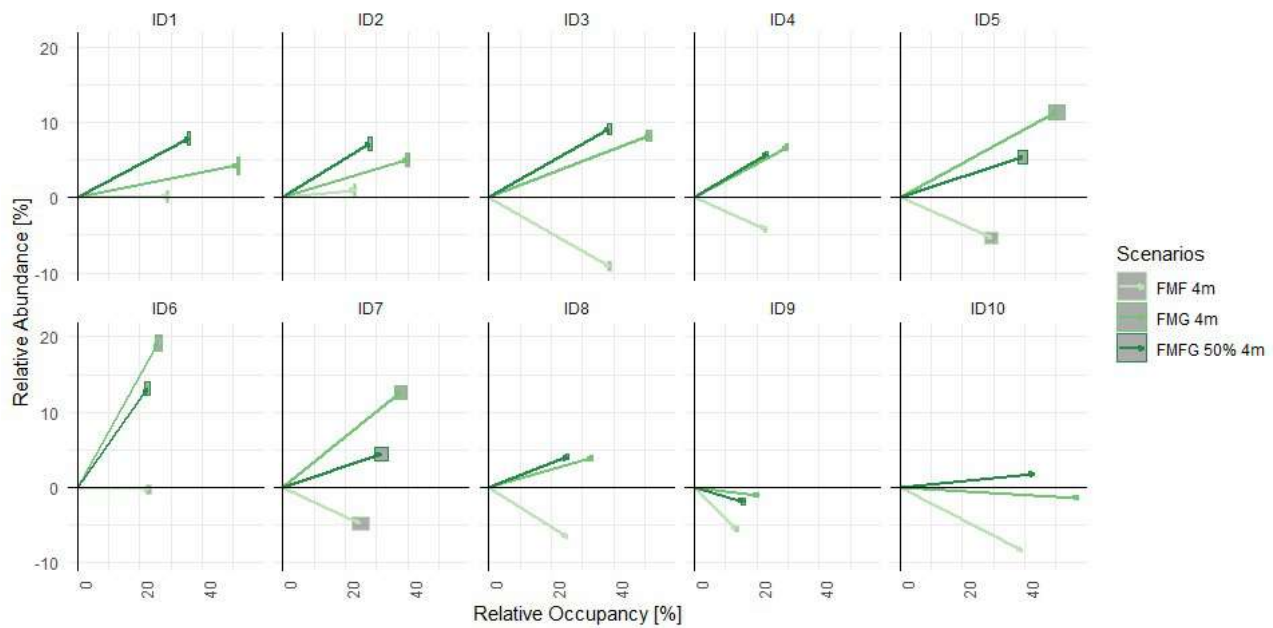


Figure 3.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes..

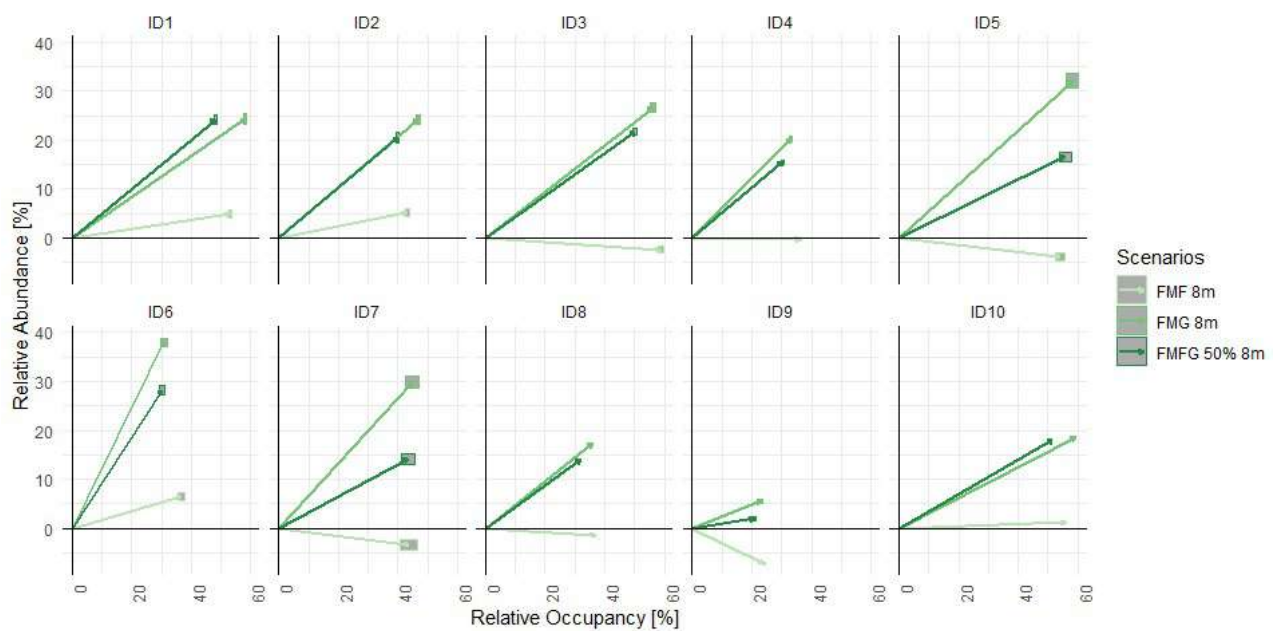


Figure 3.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4.5 Setaside

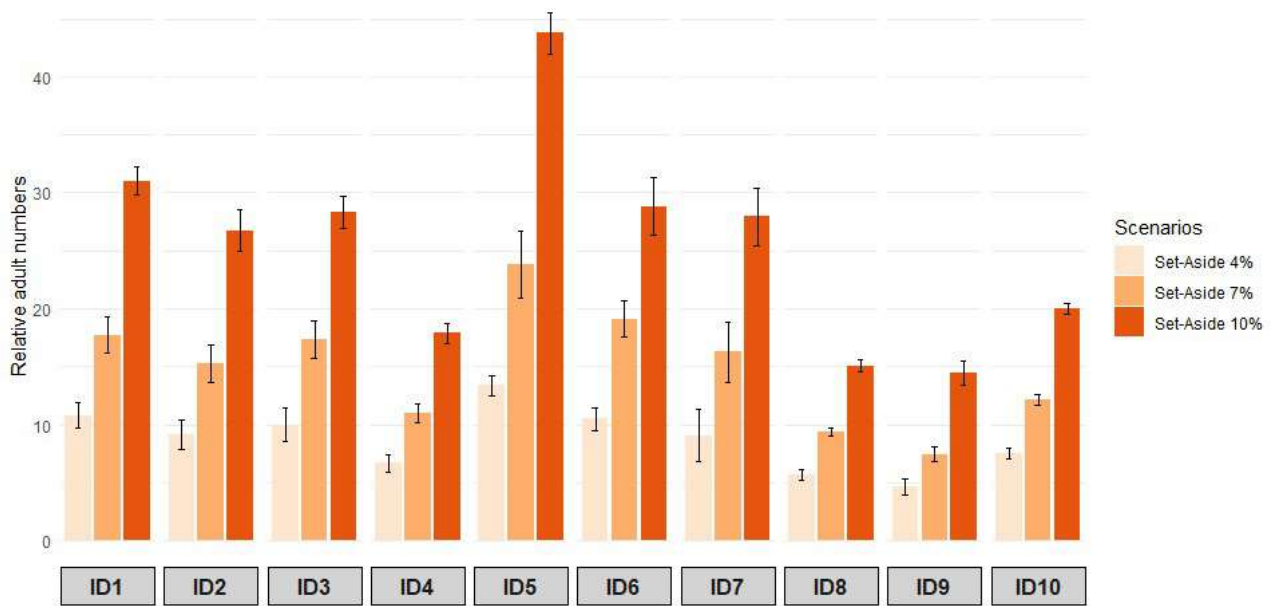


Figure 3.55 Setaside scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

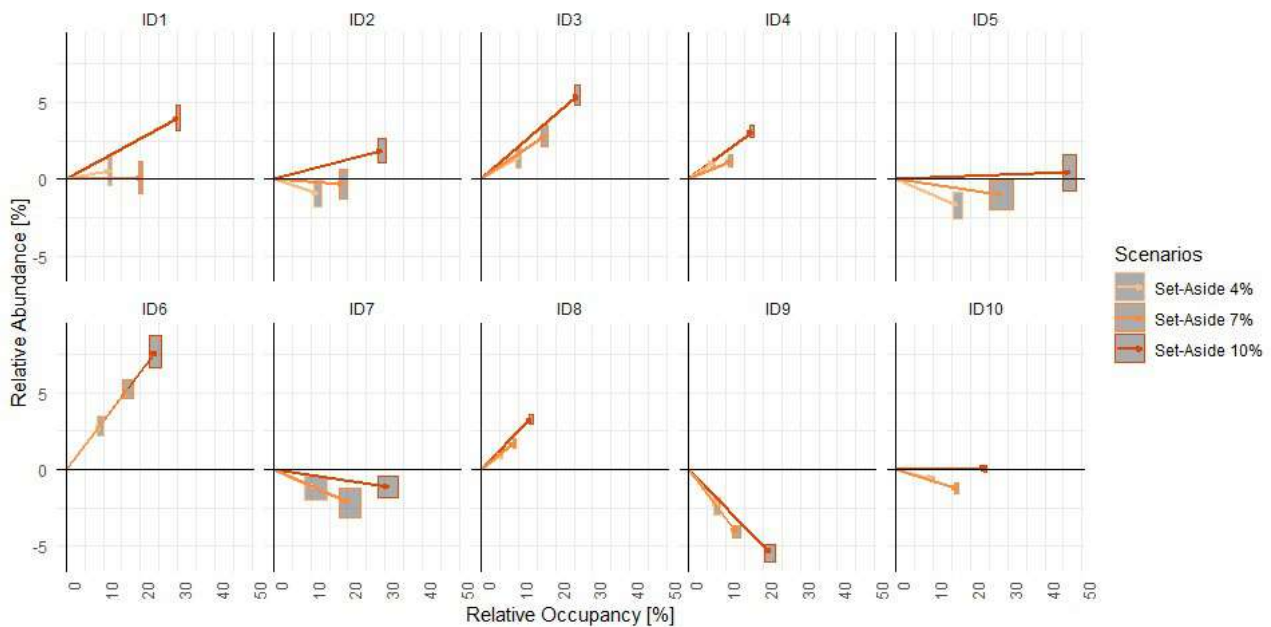


Figure 3.56 Setaside scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4.6 Legume

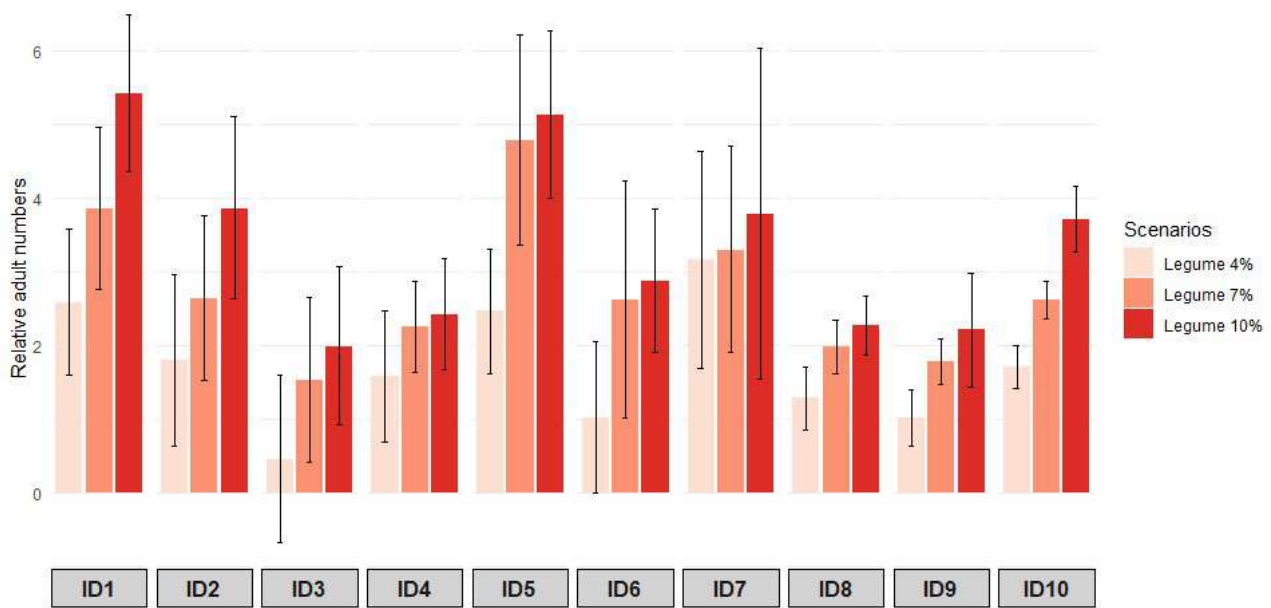


Figure 3.57 Legume scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

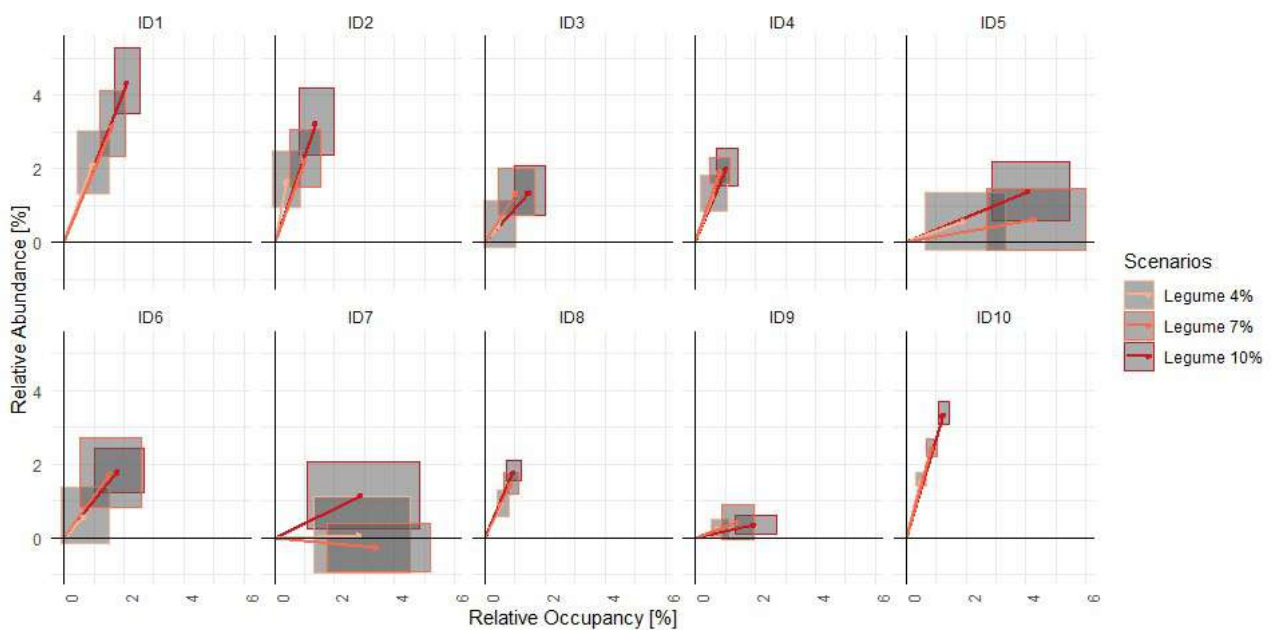


Figure 3.58 Legume scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.4.7 Biopesticides

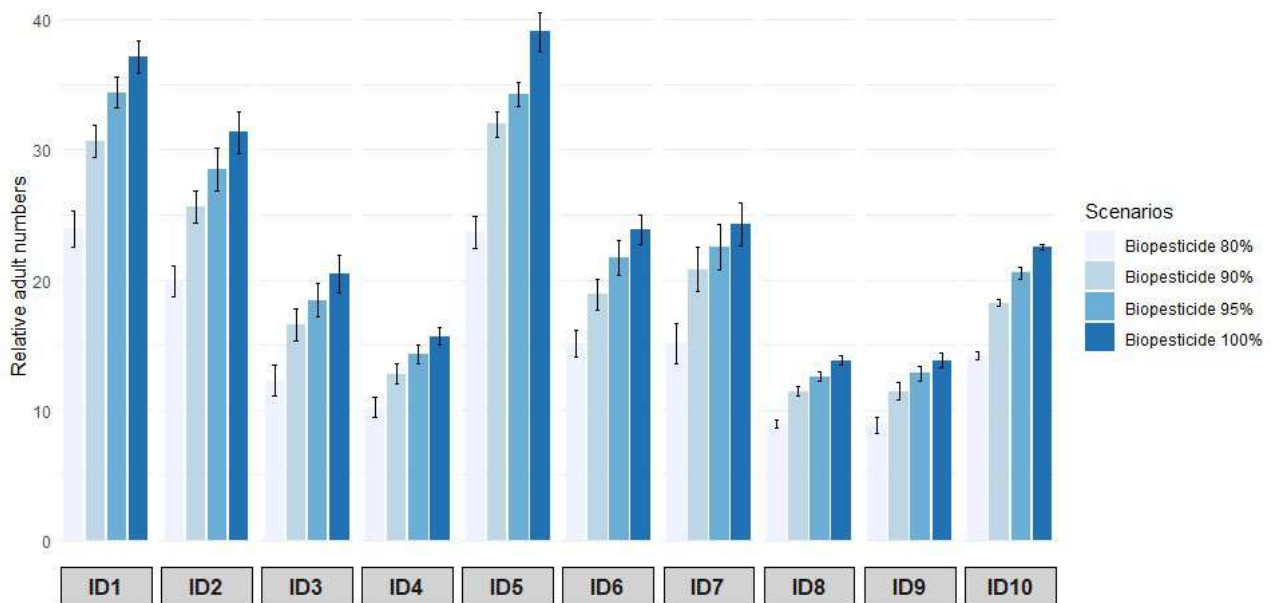


Figure 3.59 Biopesticide scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

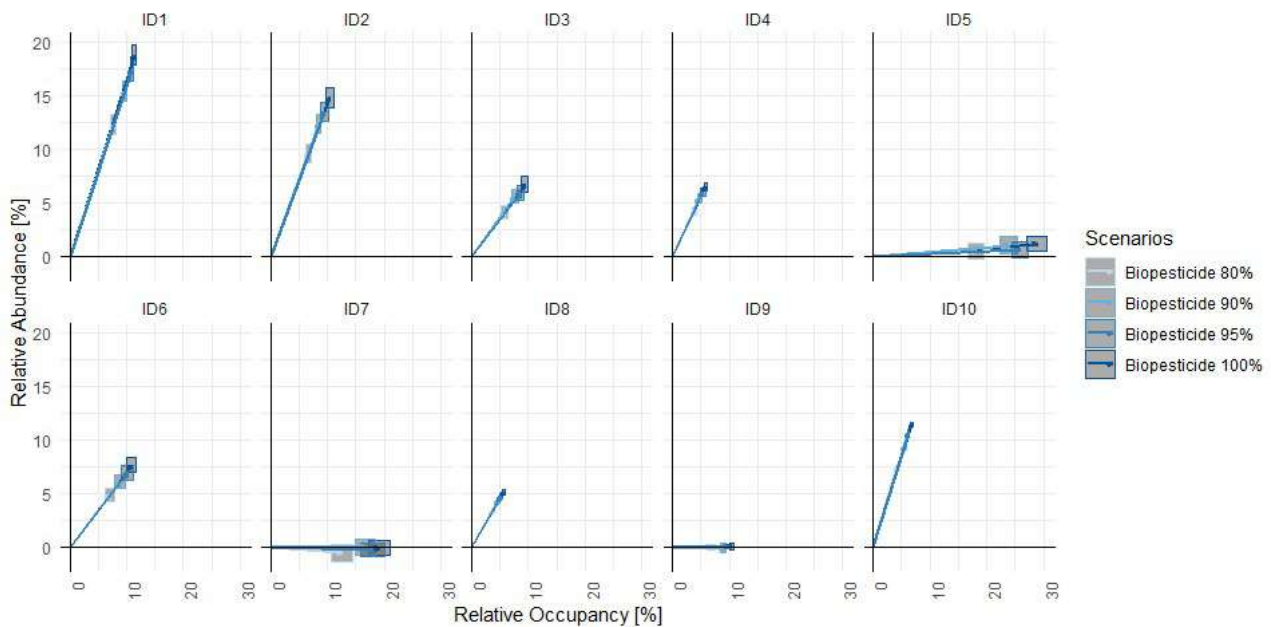


Figure 3.60 Biopesticide scenario with relative change in occupancy and abundance of adult *Bembidion* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

3.5 Combined landscapes

3.5.1 Crop diversification

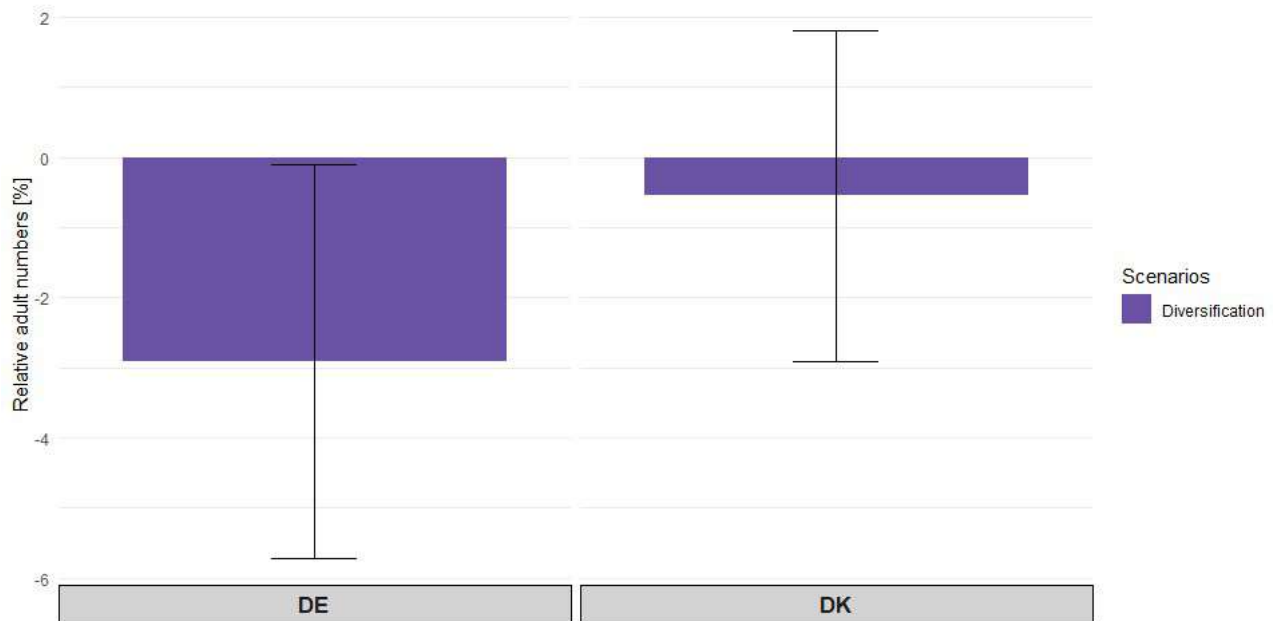


Figure 3.61 Diversification scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.2 Flower field margins

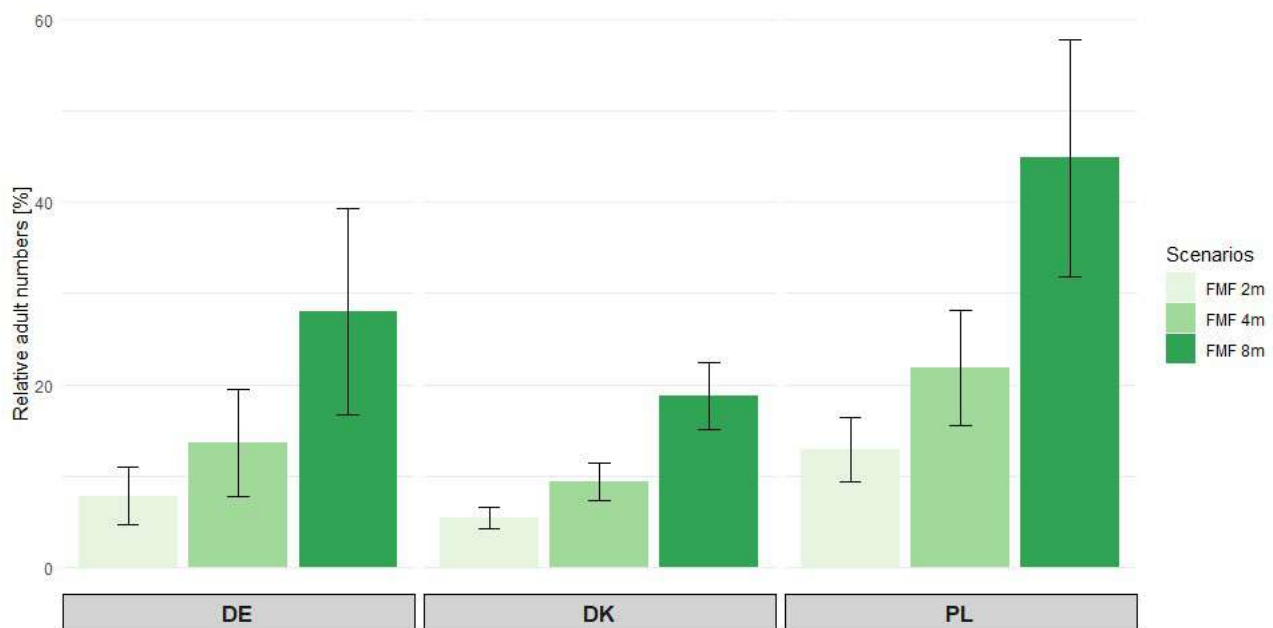


Figure 3.62 Flower field margins with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.3 Grassy field margins

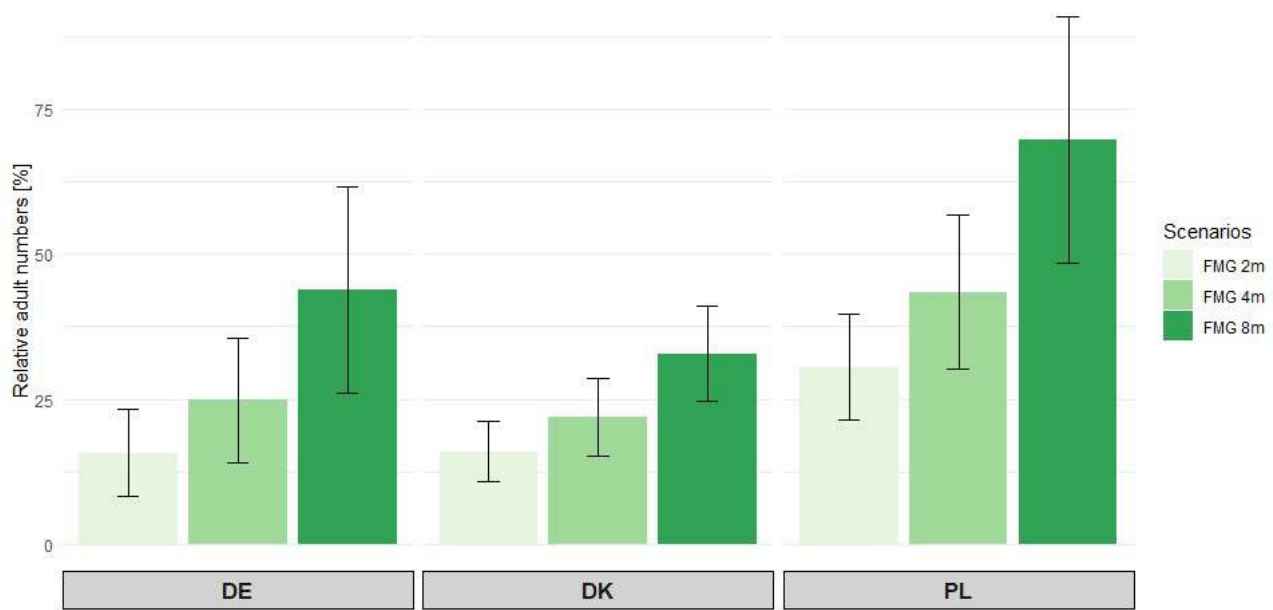


Figure 3.63 Grassy field margins with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.4 Mixed field margins

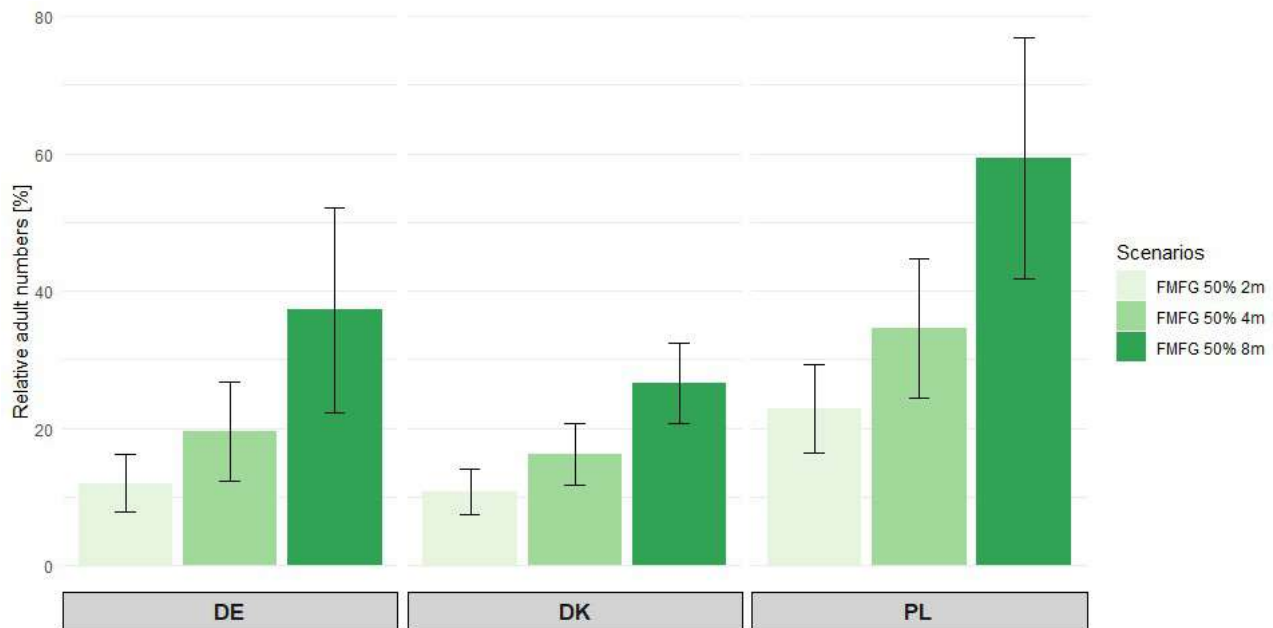


Figure 3.64 Mixed field margins with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.5 Flower, grassy and mixed margins

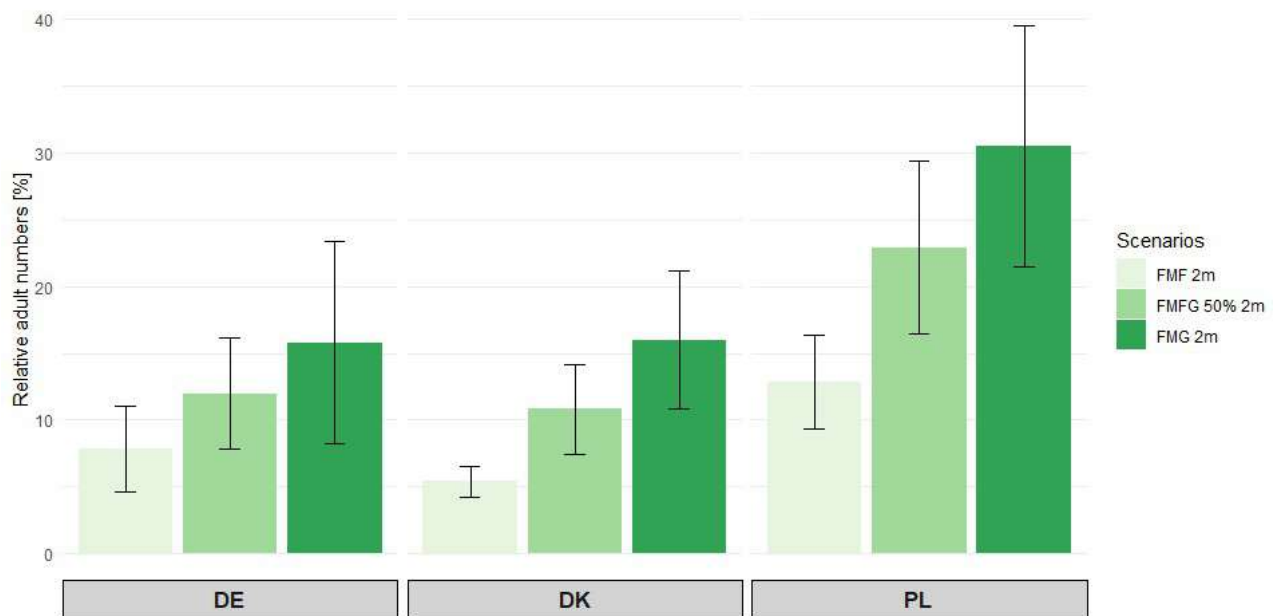


Figure 3.65 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

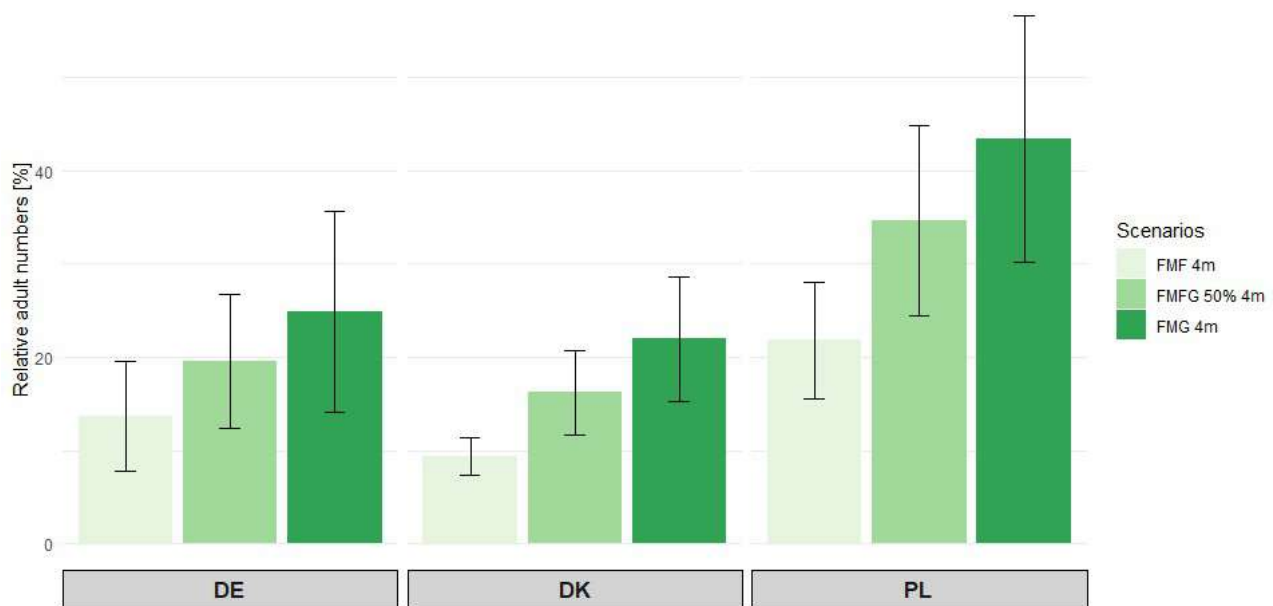


Figure 3.66 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

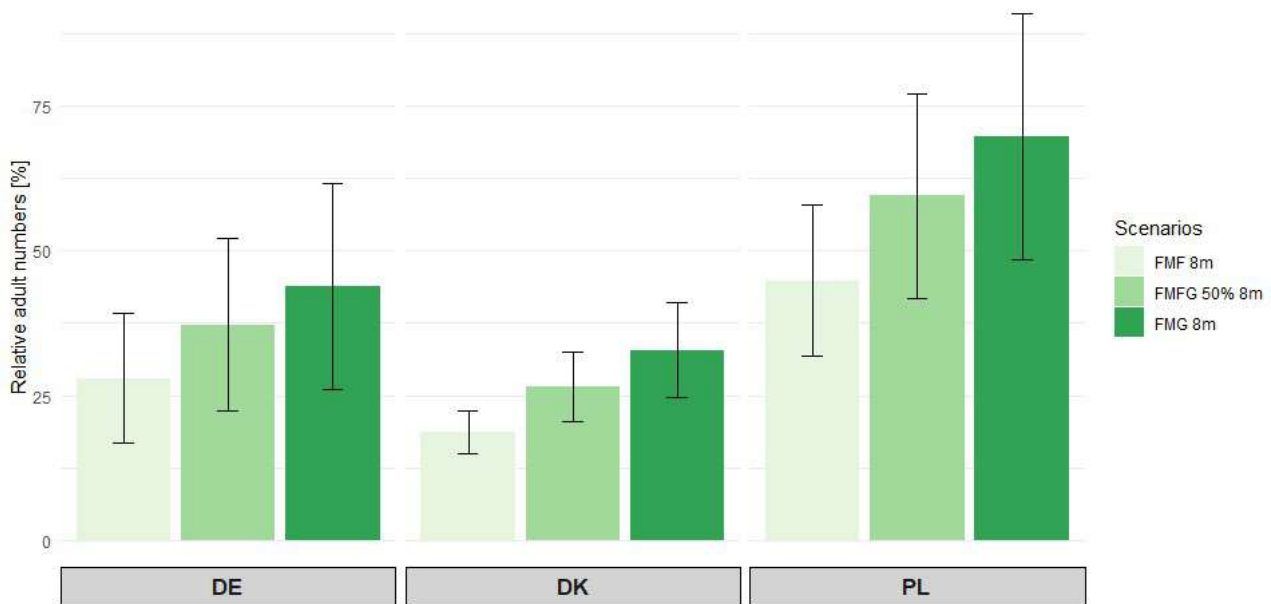


Figure 3.67 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.6 Setaside

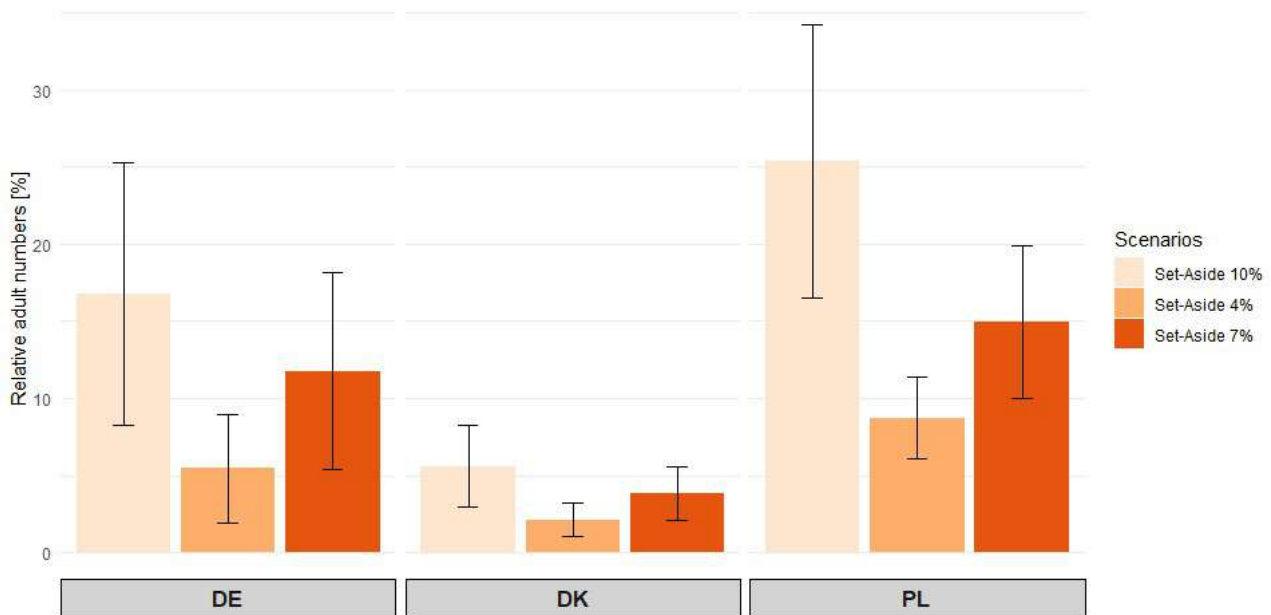


Figure 3.68 Setaside scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.7 Legume

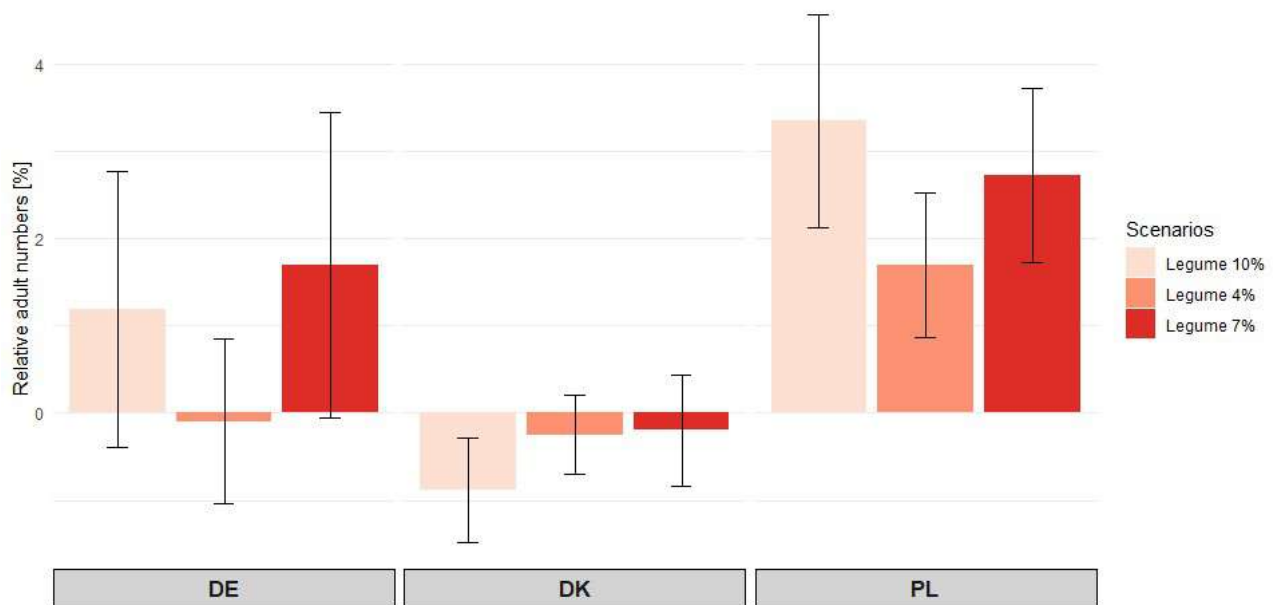


Figure 3.69 Legume scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.8 Biopesticides

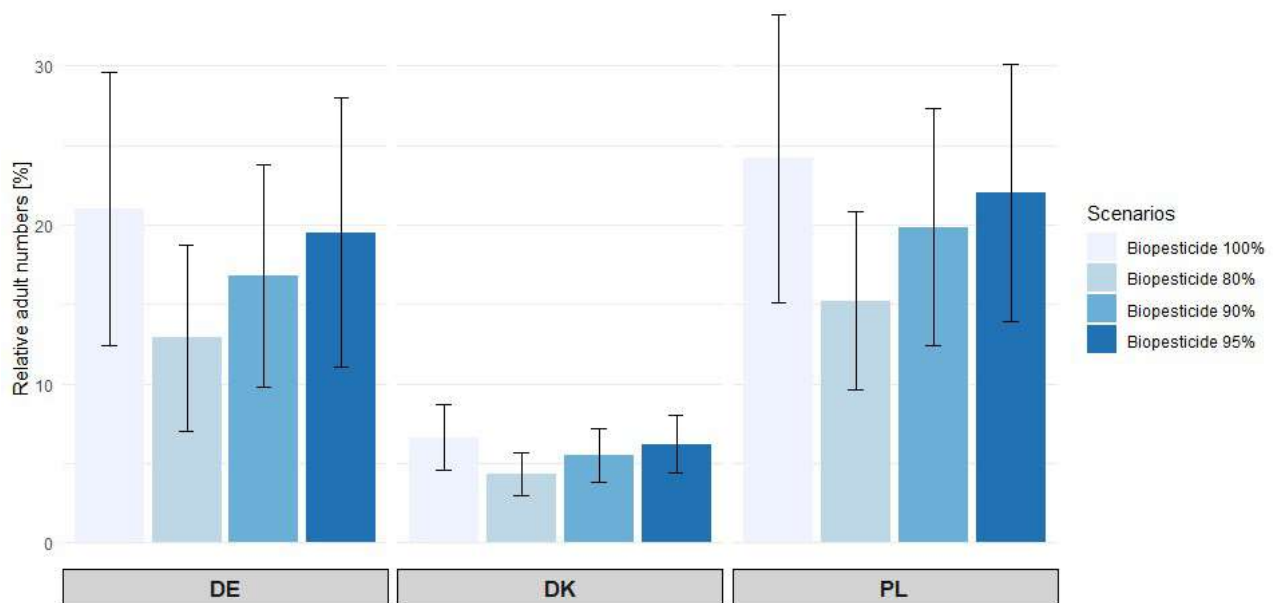


Figure 3.70 Biopesticide scenario with relative change in the number of adult *Bembidion* compared to baseline and standard deviation presented by error bars for each simulated country.

3.5.9 Table: Country level overview of scenario effects

Table 3.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for *Bembidion*. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	PL
Diversification	-3% (SD 3%)	-1% (SD 2%)	NA
FMF 2m	8% (SD 3%)	5% (SD 1%)	13% (SD 4%)
FMF 4m	14% (SD 6%)	9% (SD 2%)	22% (SD 6%)
FMF 8m	28% (SD 11%)	19% (SD 4%)	45% (SD 13%)
FMG 2m	16% (SD 8%)	16% (SD 5%)	31% (SD 9%)
FMG 4m	25% (SD 11%)	22% (SD 7%)	43% (SD 13%)
FMG 8m	44% (SD 18%)	33% (SD 8%)	70% (SD 21%)
FMFG 50% 2m	12% (SD 4%)	11% (SD 3%)	23% (SD 6%)
FMFG 50% 4m	20% (SD 7%)	16% (SD 5%)	35% (SD 10%)
FMFG 50% 8m	37% (SD 15%)	27% (SD 6%)	59% (SD 18%)
Set-Aside 4%	5% (SD 4%)	2% (SD 1%)	9% (SD 3%)
Set-Aside 7%	12% (SD 6%)	4% (SD 2%)	15% (SD 5%)
Set-Aside 10%	17% (SD 9%)	6% (SD 3%)	25% (SD 9%)
Legume 4%	-0% (SD 1%)	-0% (SD 0%)	2% (SD 1%)
Legume 7%	2% (SD 2%)	-0% (SD 1%)	3% (SD 1%)
Legume 10%	1% (SD 2%)	-1% (SD 1%)	3% (SD 1%)
Biopesticide 80%	13% (SD 6%)	4% (SD 1%)	15% (SD 6%)
Biopesticide 90%	17% (SD 7%)	5% (SD 2%)	20% (SD 7%)
Biopesticide 95%	20% (SD 8%)	6% (SD 2%)	22% (SD 8%)
Biopesticide 100%	21% (SD 9%)	7% (SD 2%)	24% (SD 9%)

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4 OEDOTHORAX

4.1 Baselines

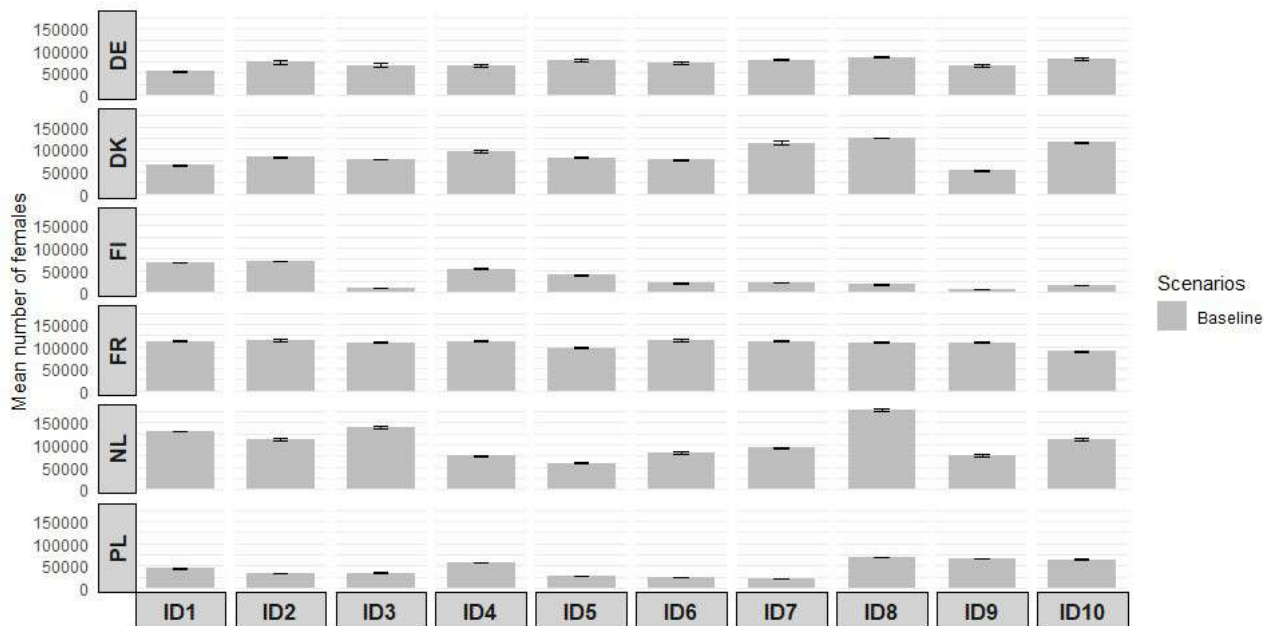


Figure 4.1 Oedothorax baselines for each country and landscape.

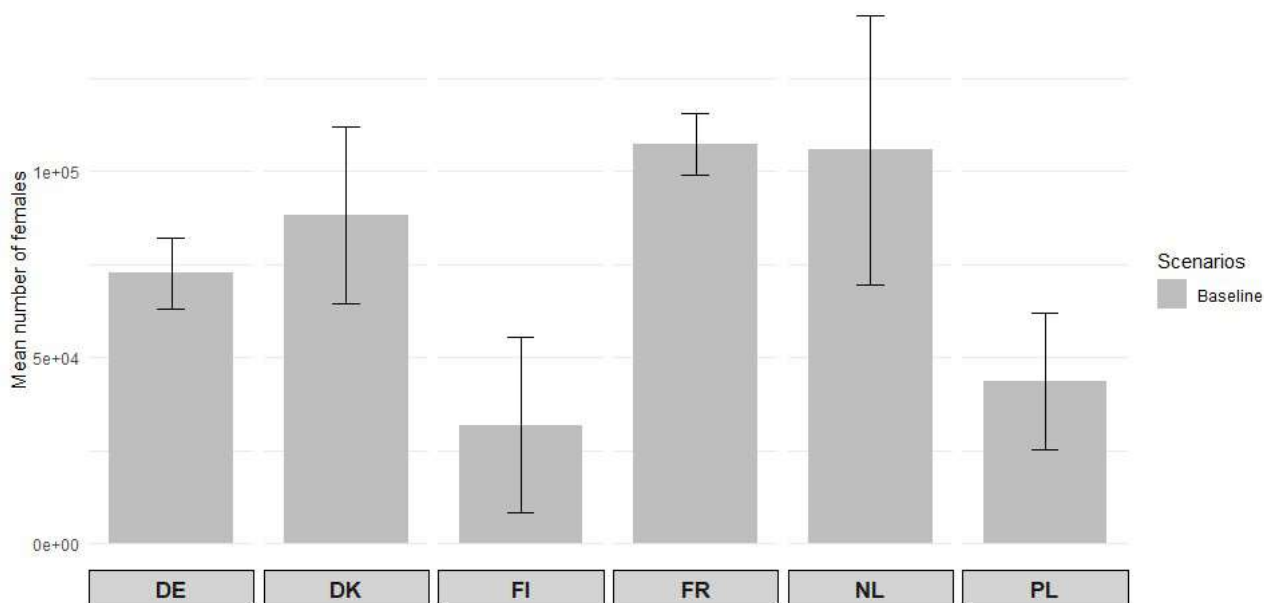


Figure 4.2 Oedothorax baselines for each country combined across landscapes.

4.2 Germany

4.2.1 Crop diversification

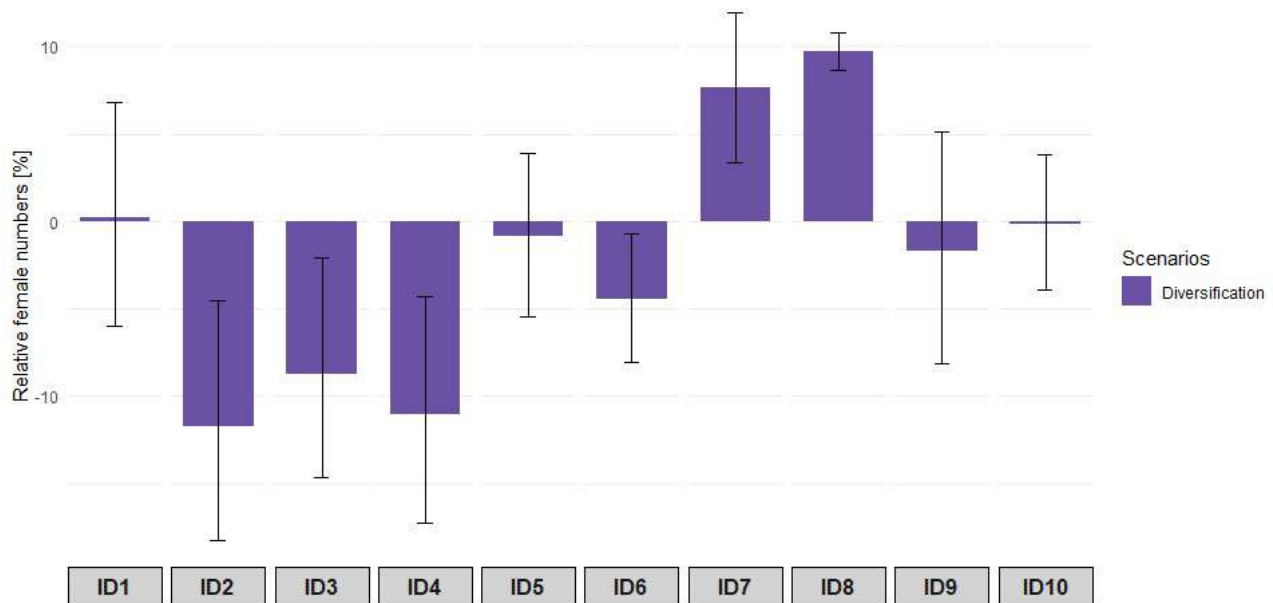


Figure 4.3 Diversification scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

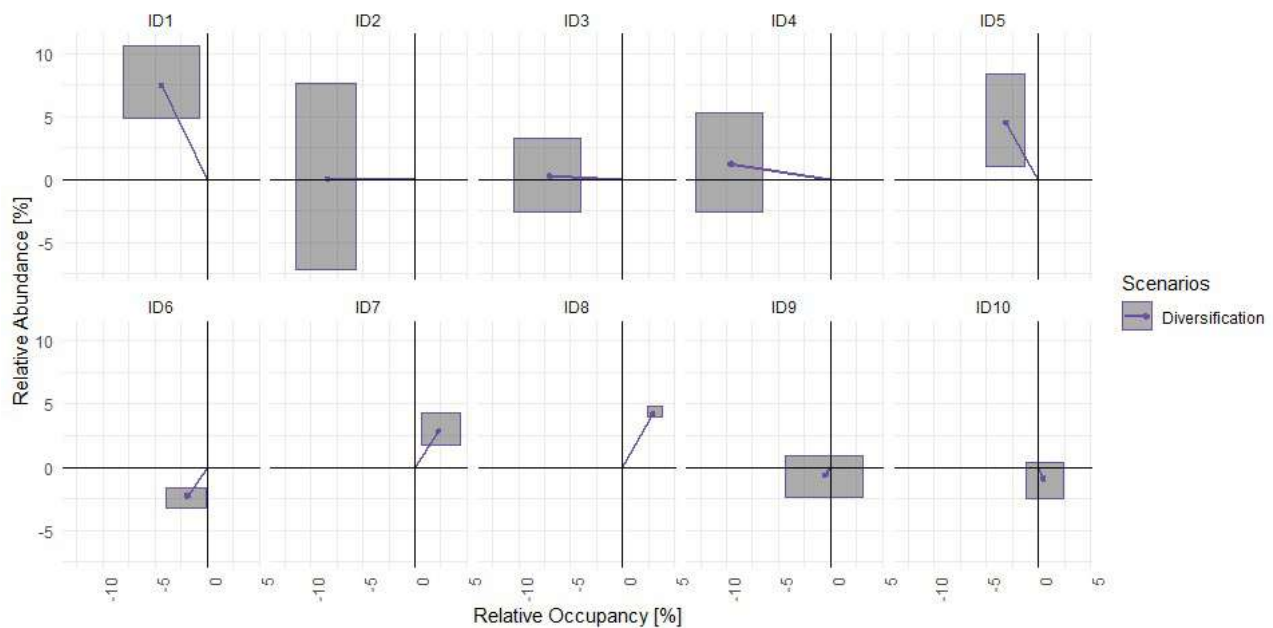


Figure 4.4 Diversification scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.2 Flower field margins

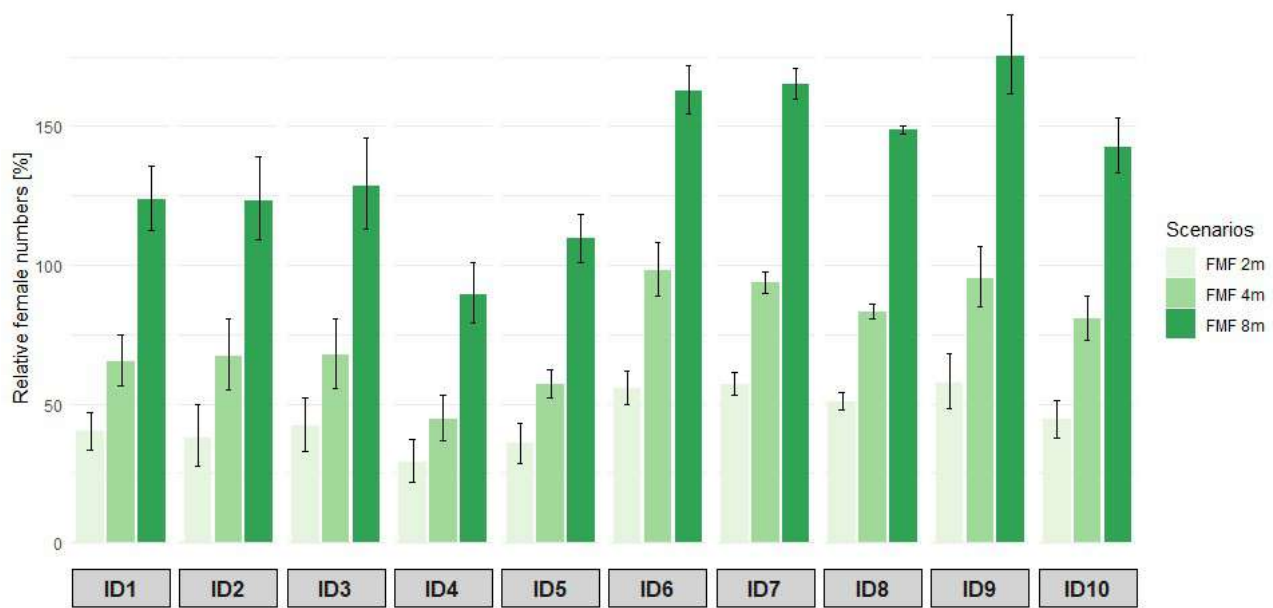


Figure 4.5 Flower field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

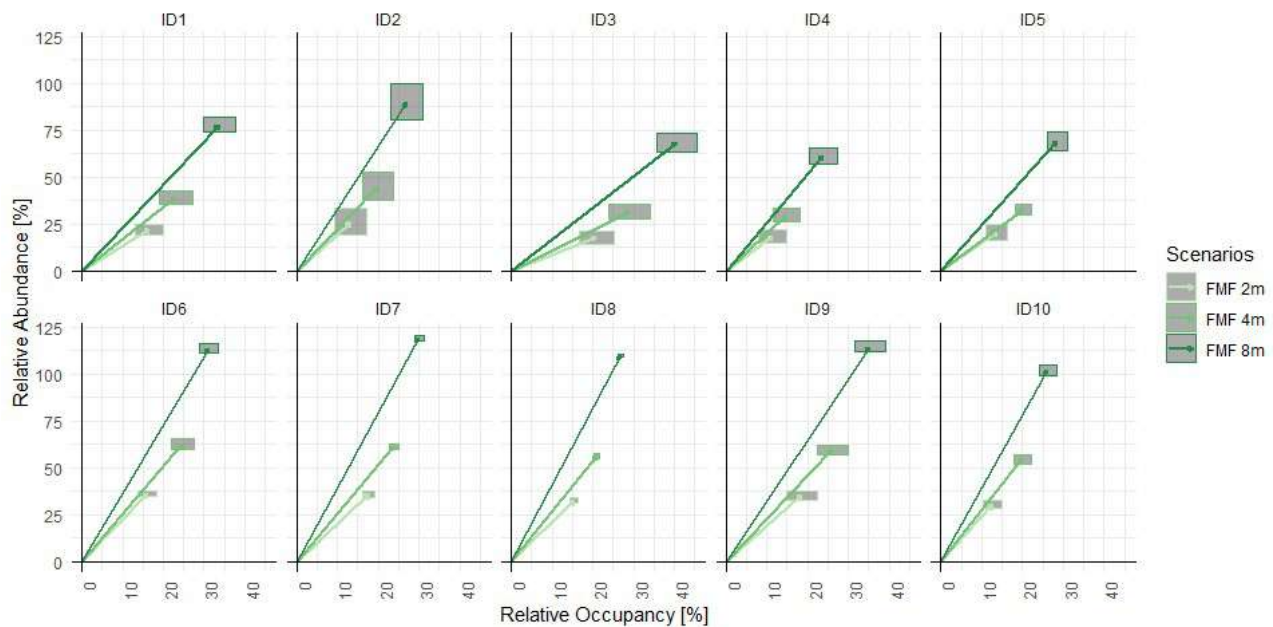


Figure 4.6 Flower field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.3 Grassy field margins

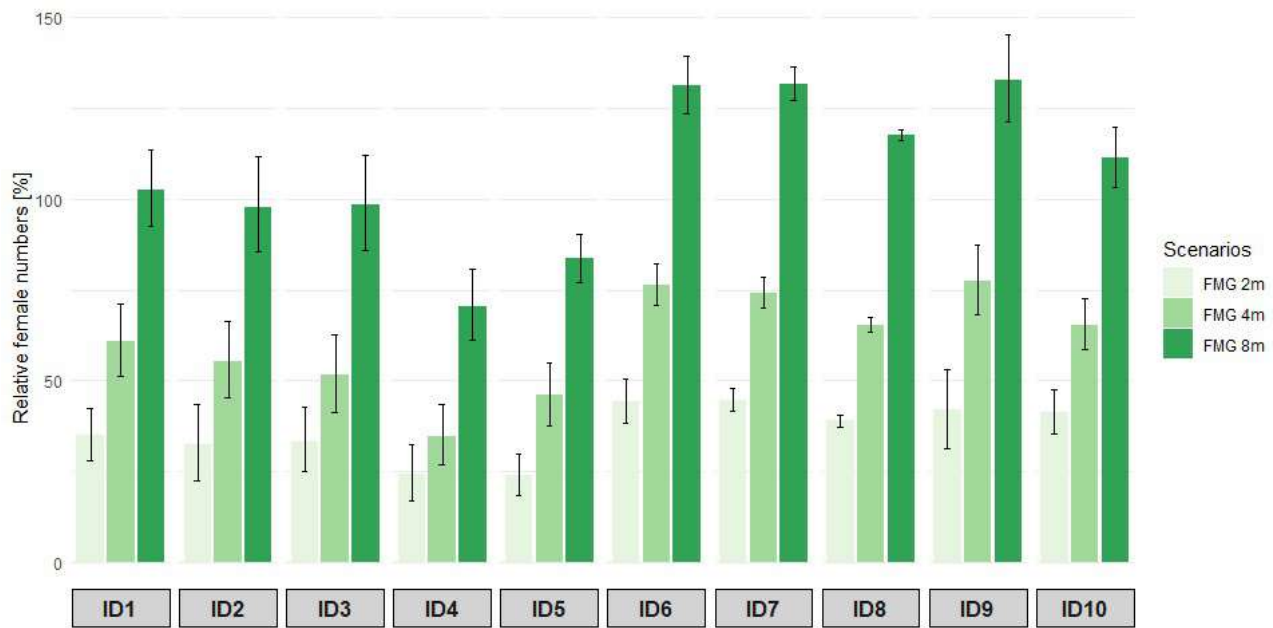


Figure 4.7 Grassy field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

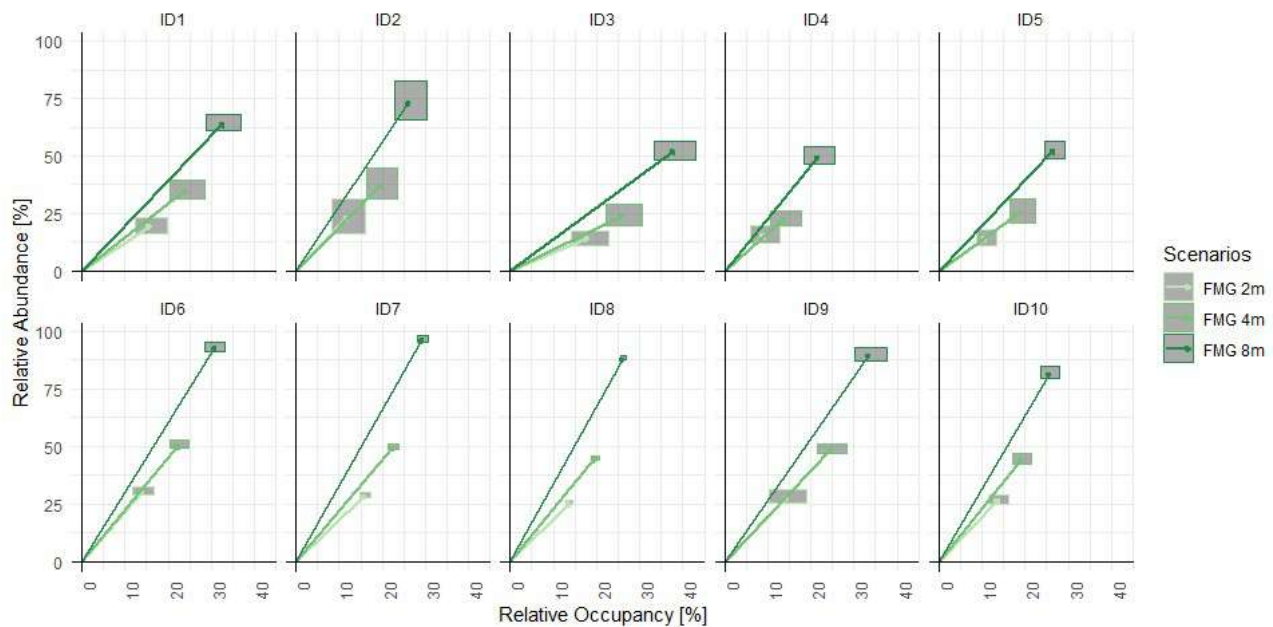


Figure 4.8 Grassy field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.4 Mixed field margins

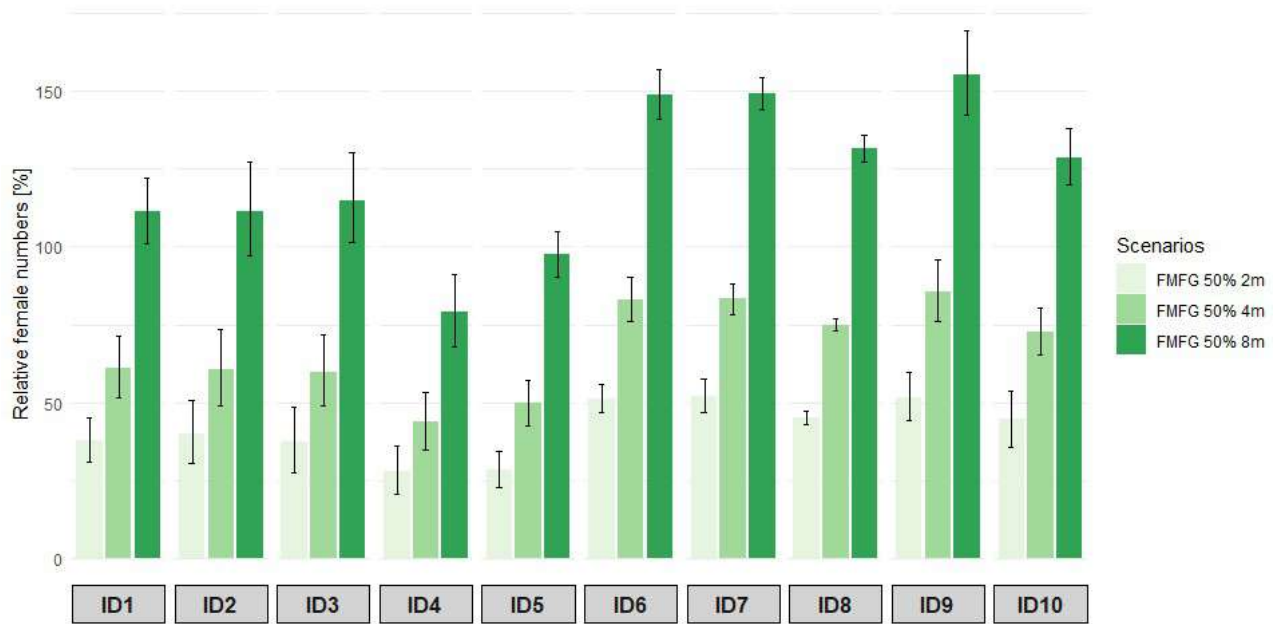


Figure 4.9 Mixed field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

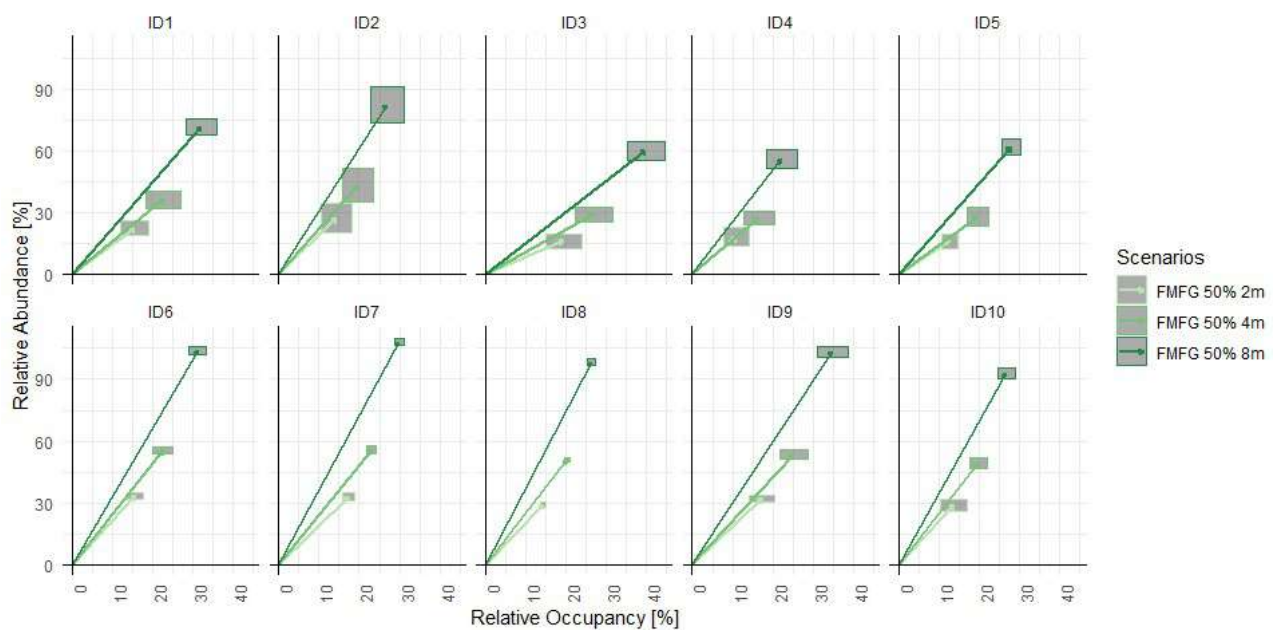


Figure 4.10 Mixed field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.5 Flower, grassy and mixed field margins

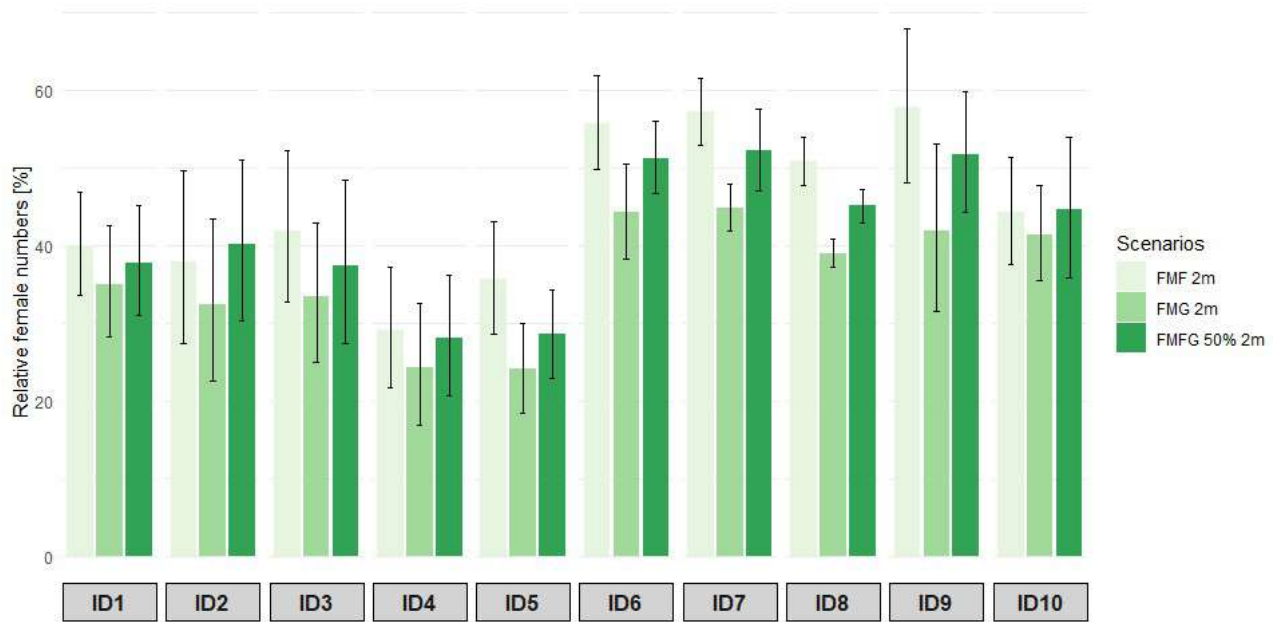


Figure 4.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

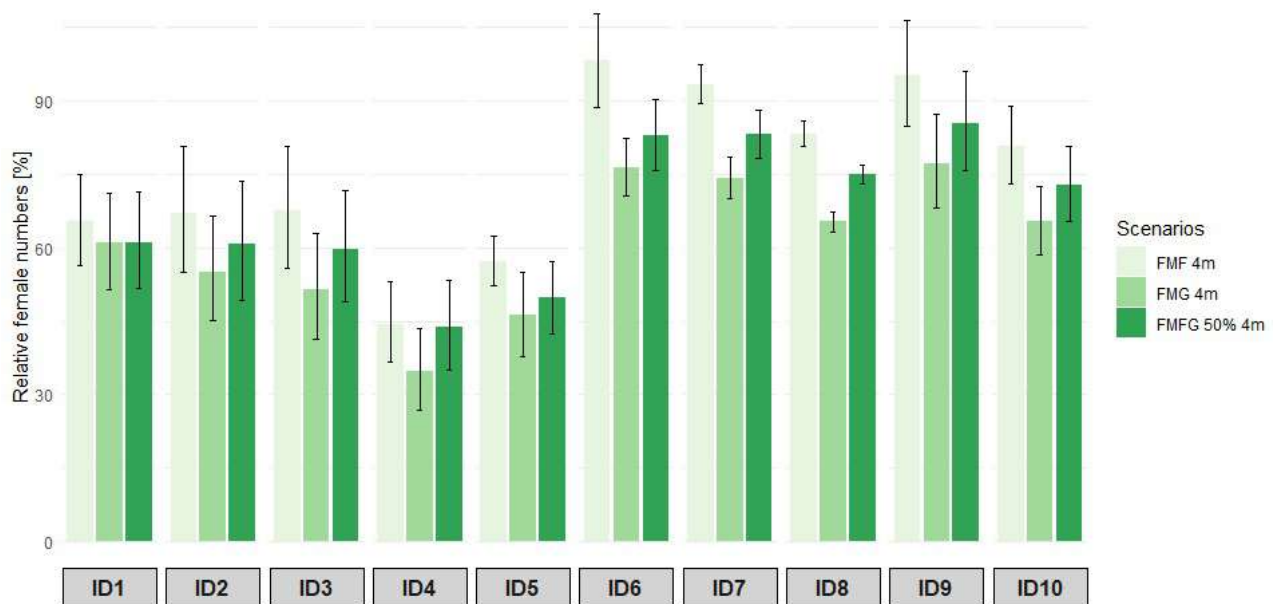


Figure 4.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

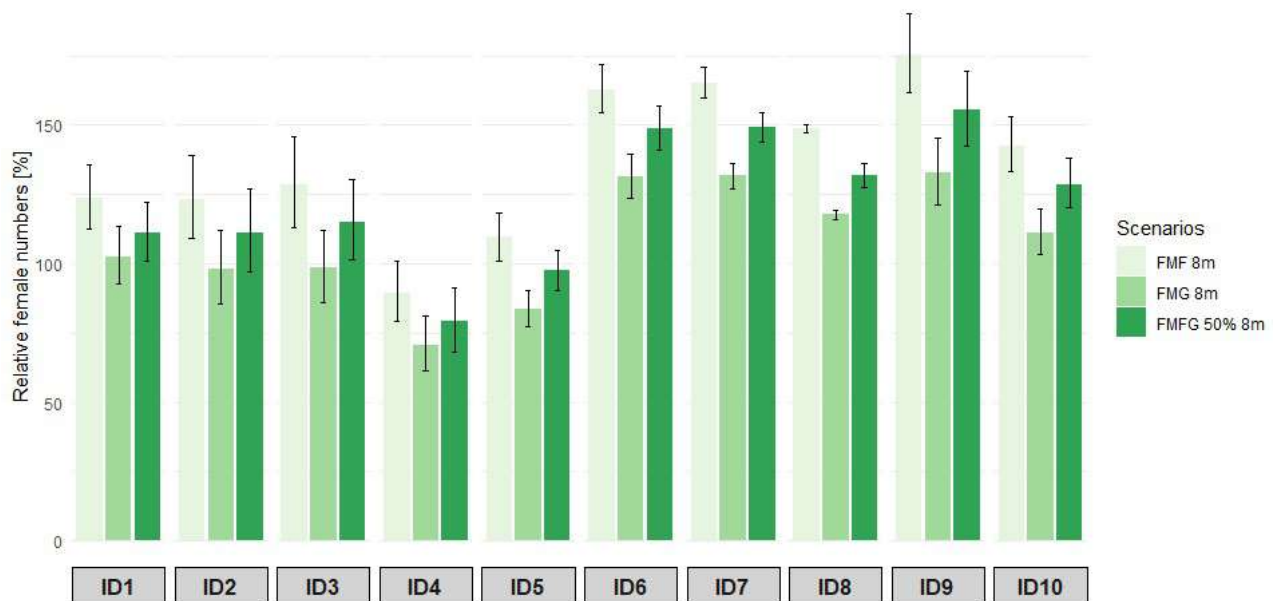


Figure 4.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

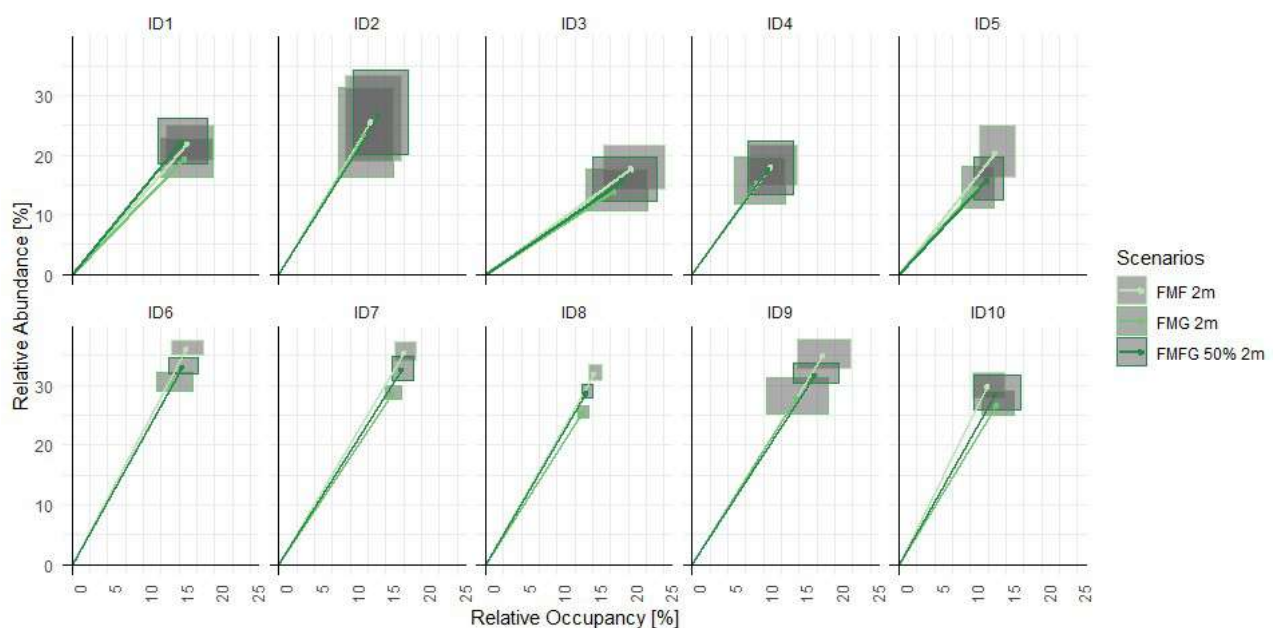


Figure 4.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

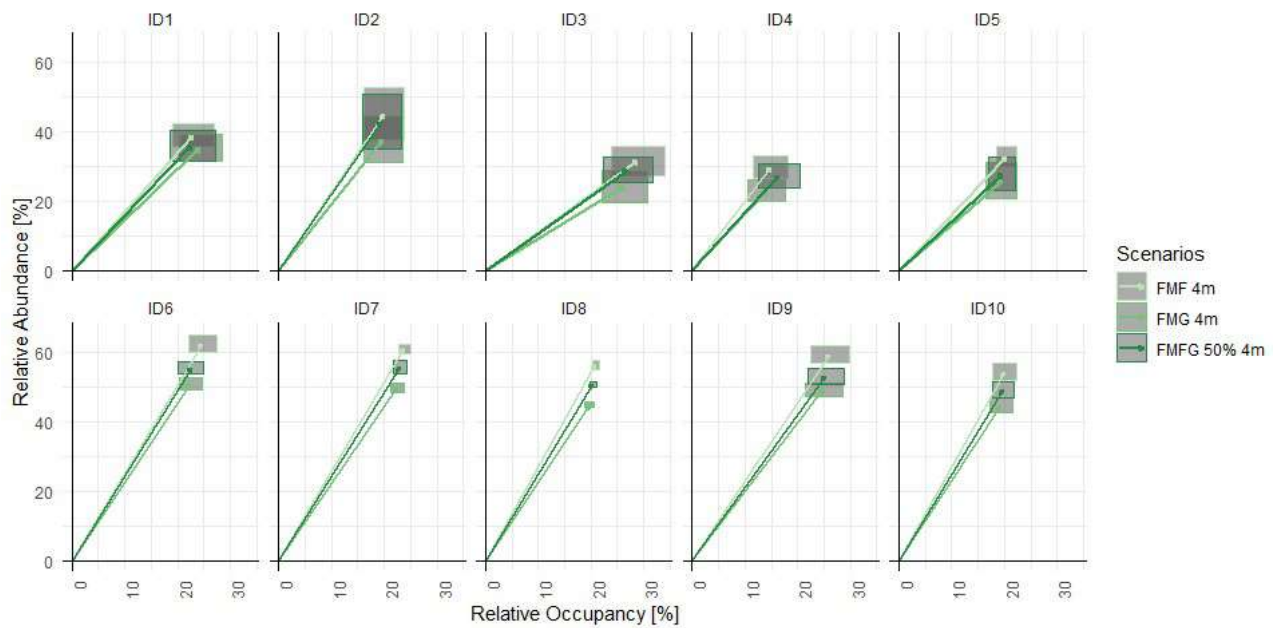


Figure 4.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes..

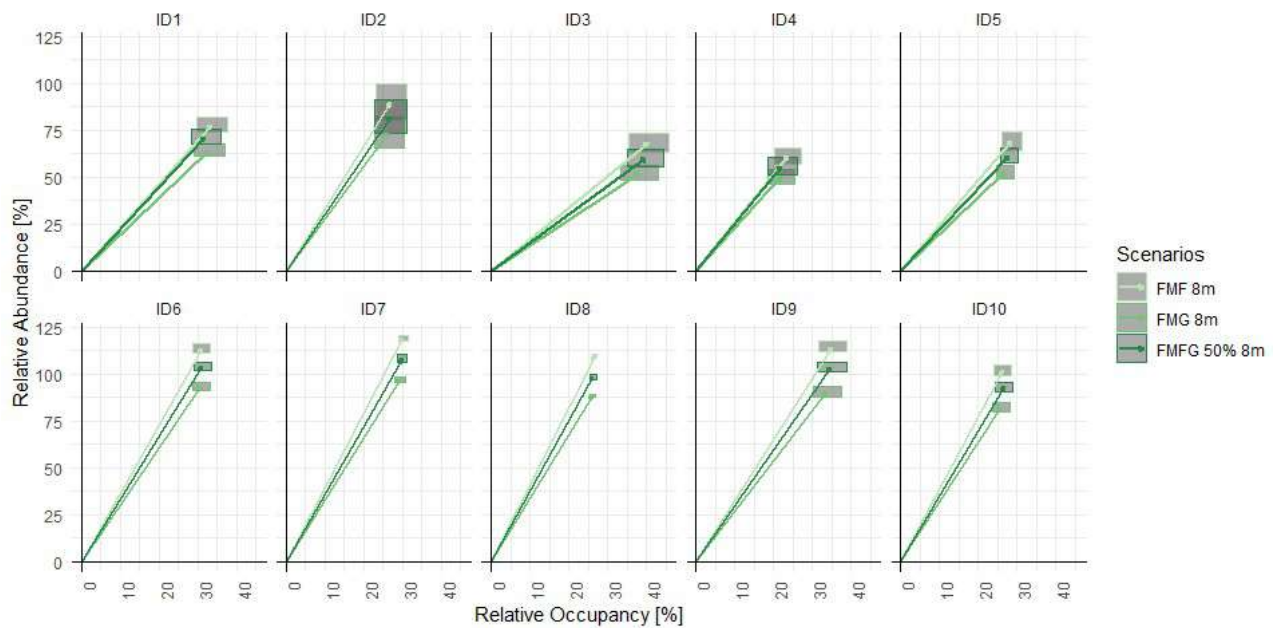


Figure 4.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.6 Setaside

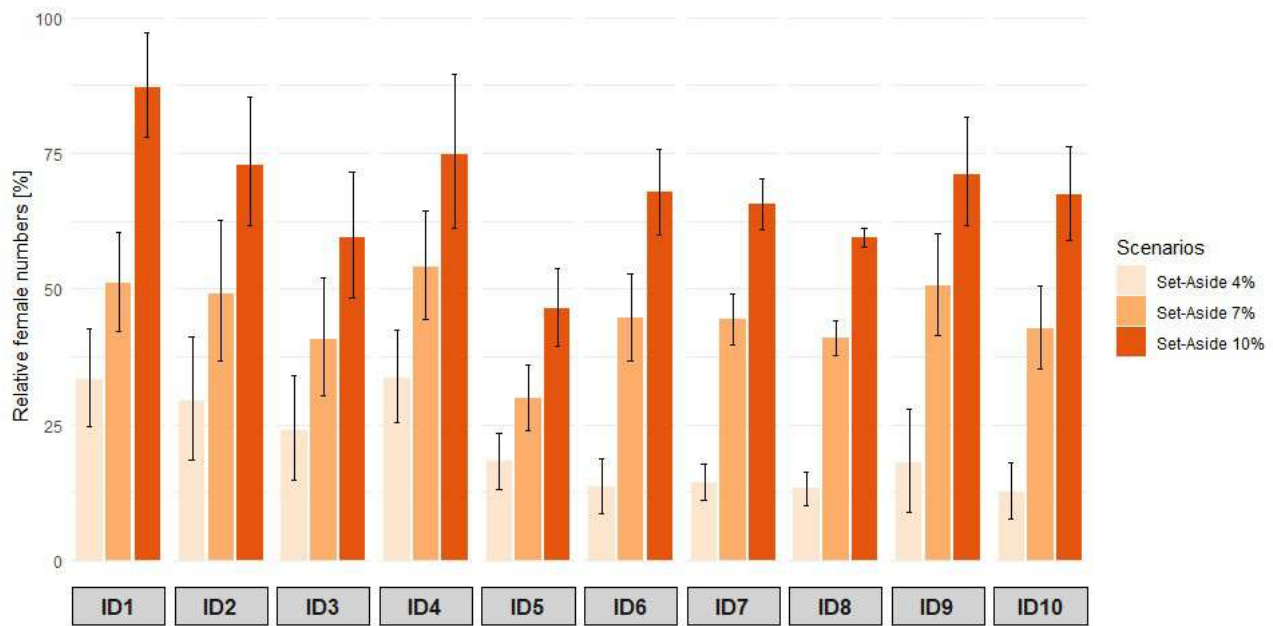


Figure 4.17 Setaside scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

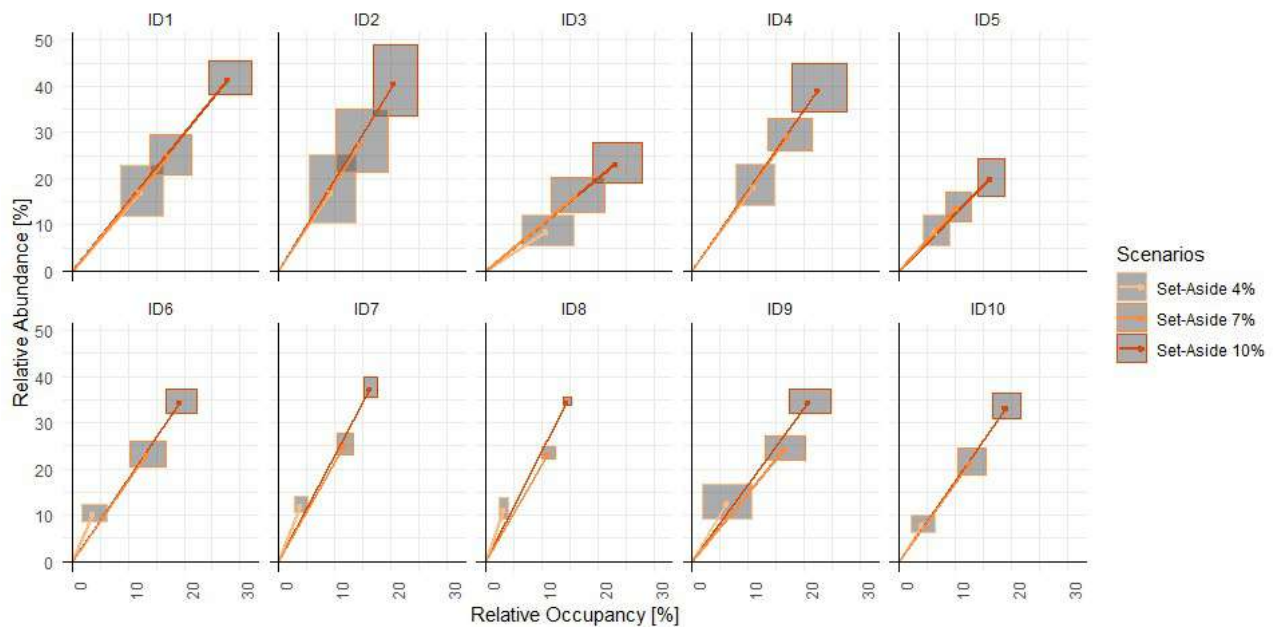


Figure 4.18 Setaside scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.7 Legume

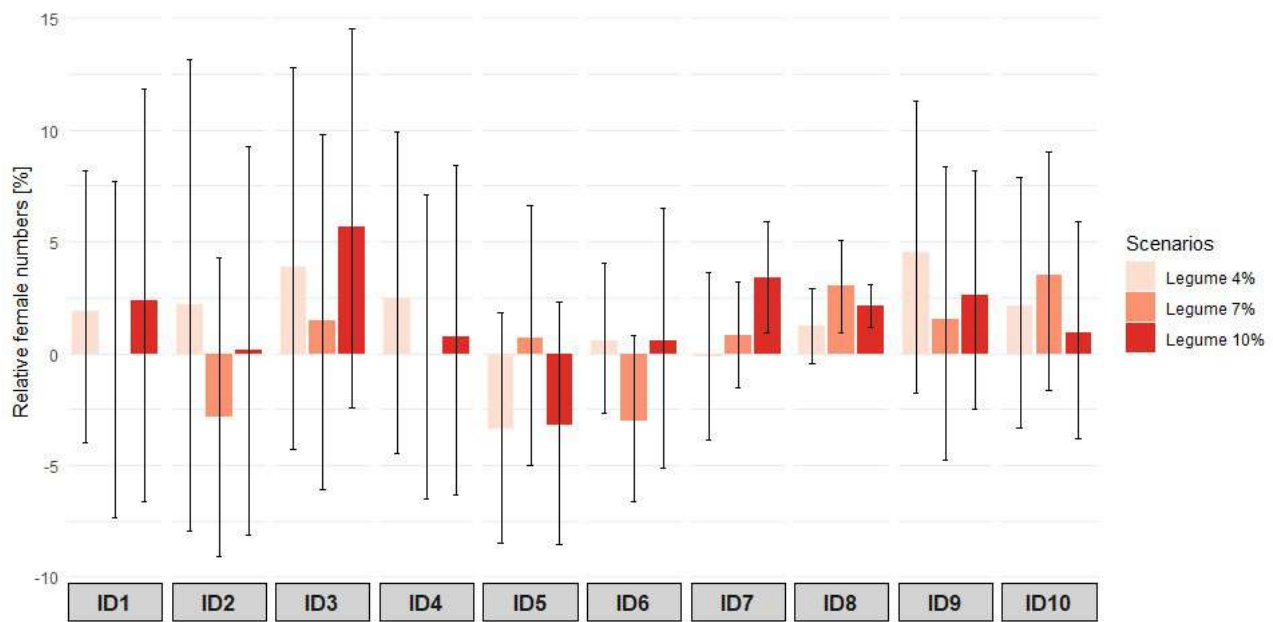


Figure 4.19 Legume scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

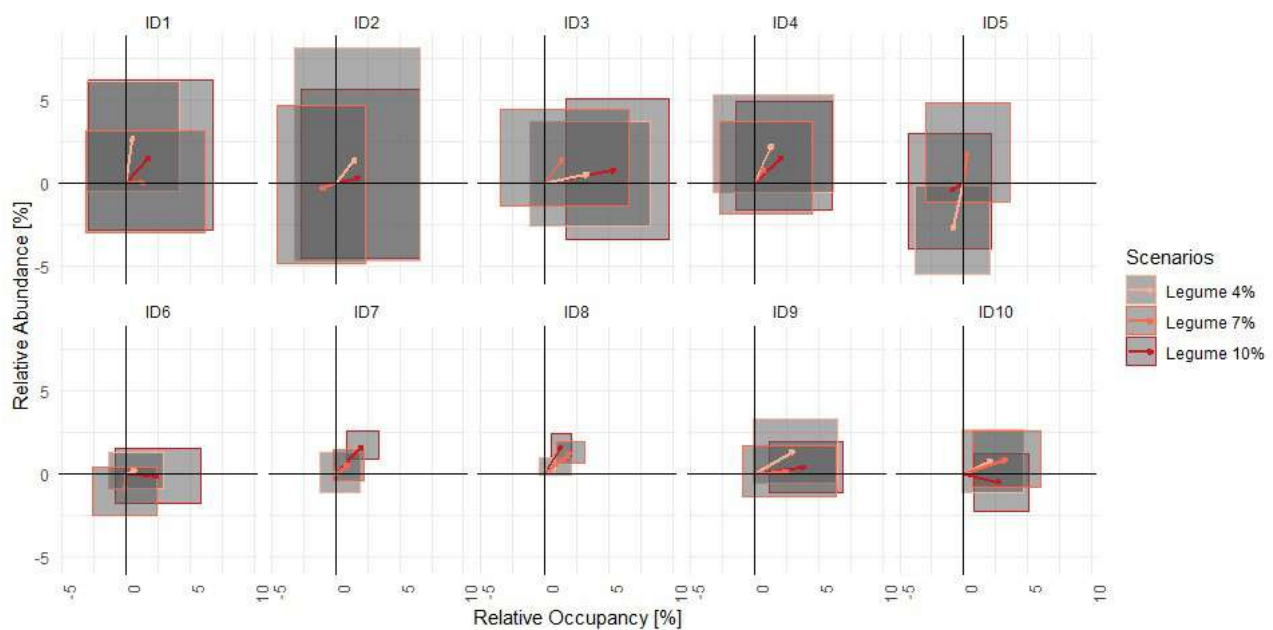


Figure 4.20 Legume scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.2.8 Biopesticides

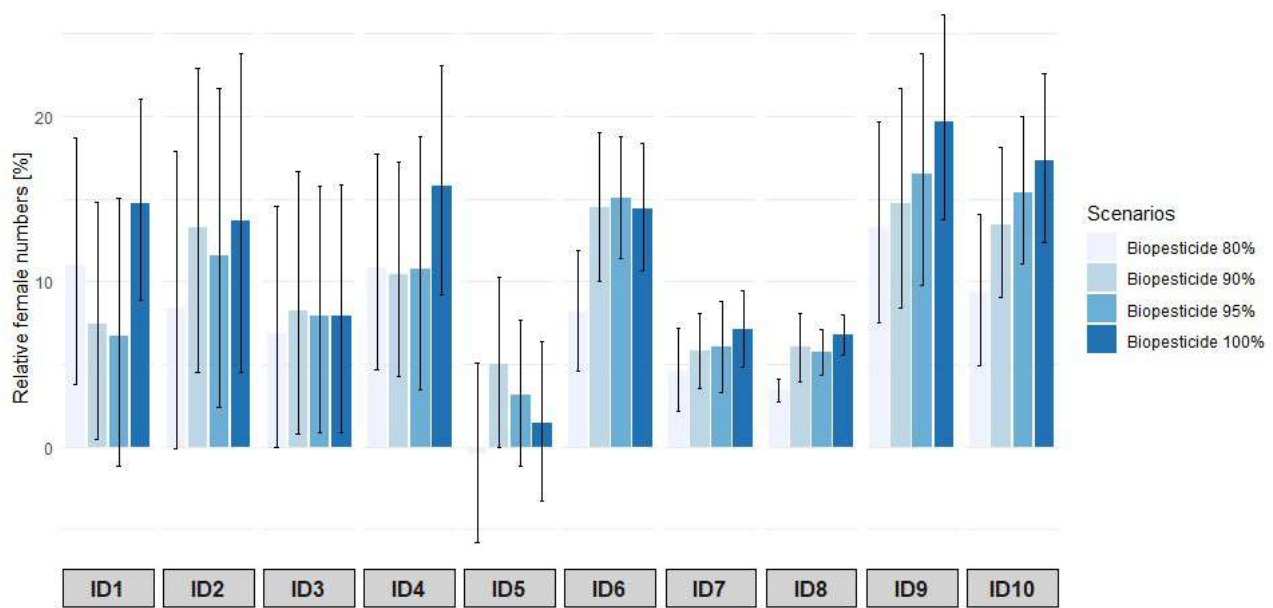


Figure 4.21 Biopesticide scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

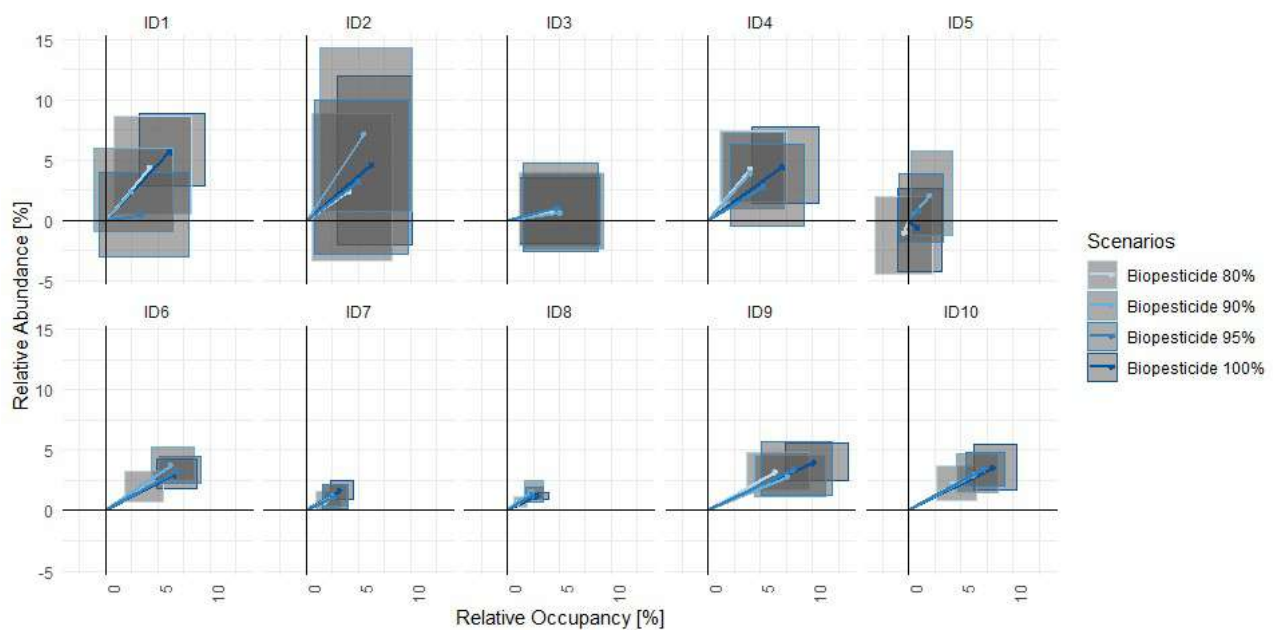


Figure 4.22 Biopesticide scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3 Denmark

4.3.1 Crop diversification

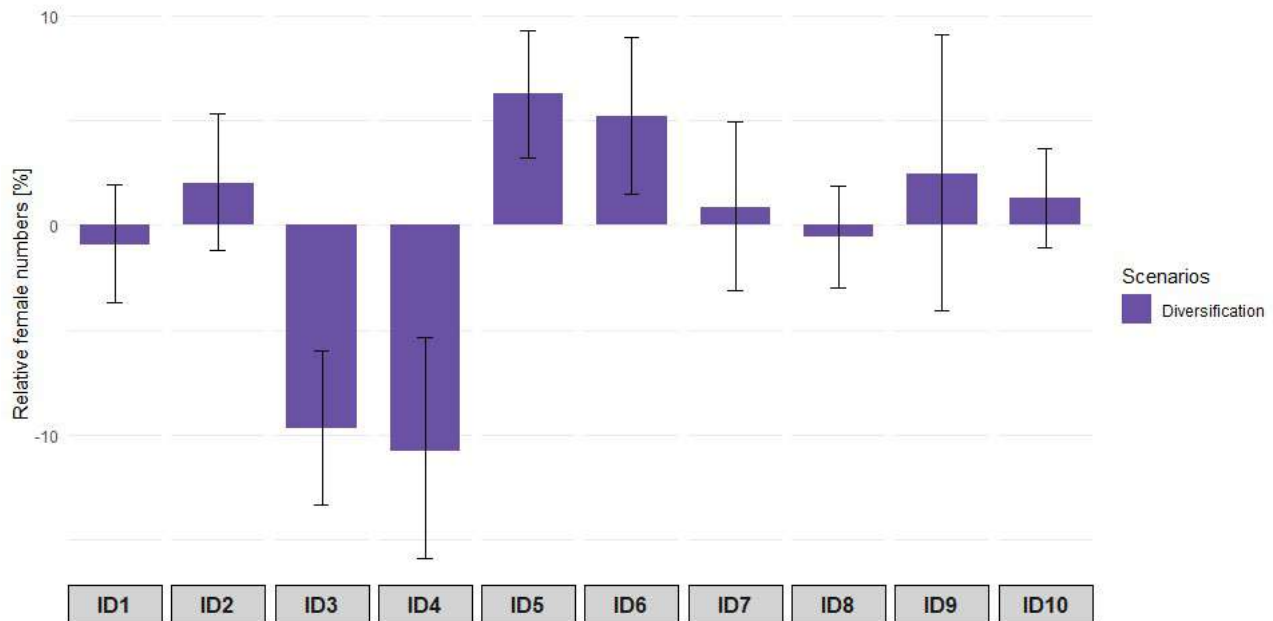


Figure 4.23 Diversification scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

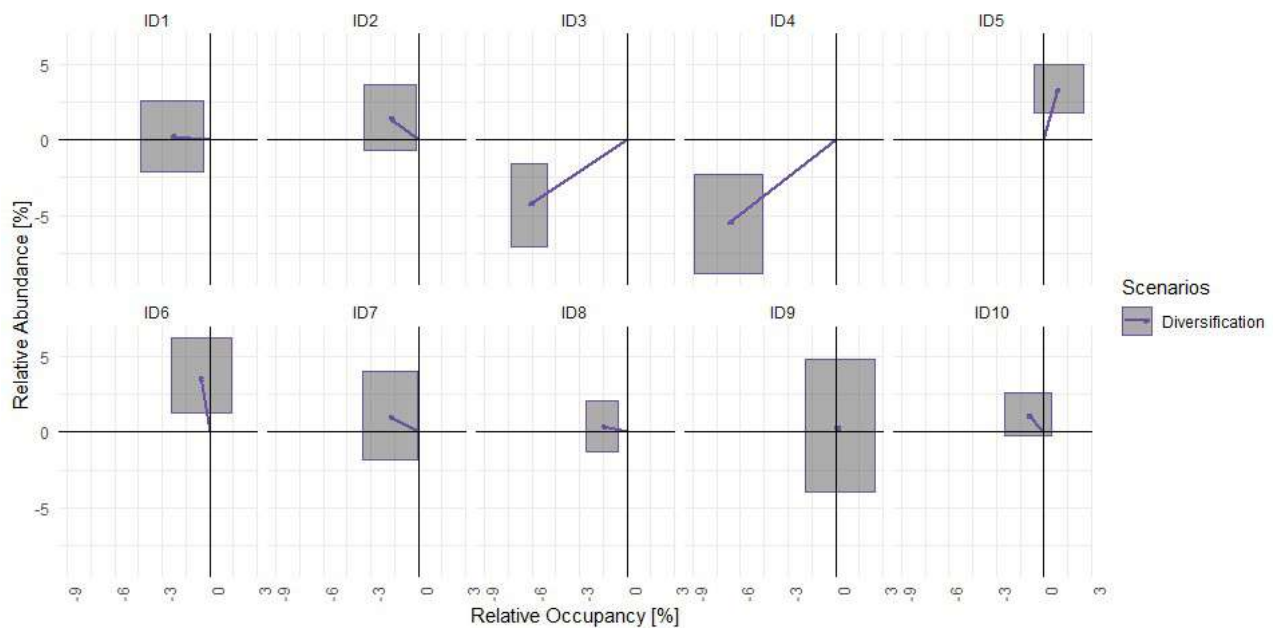


Figure 4.24 Diversification scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.2 Flower field margins

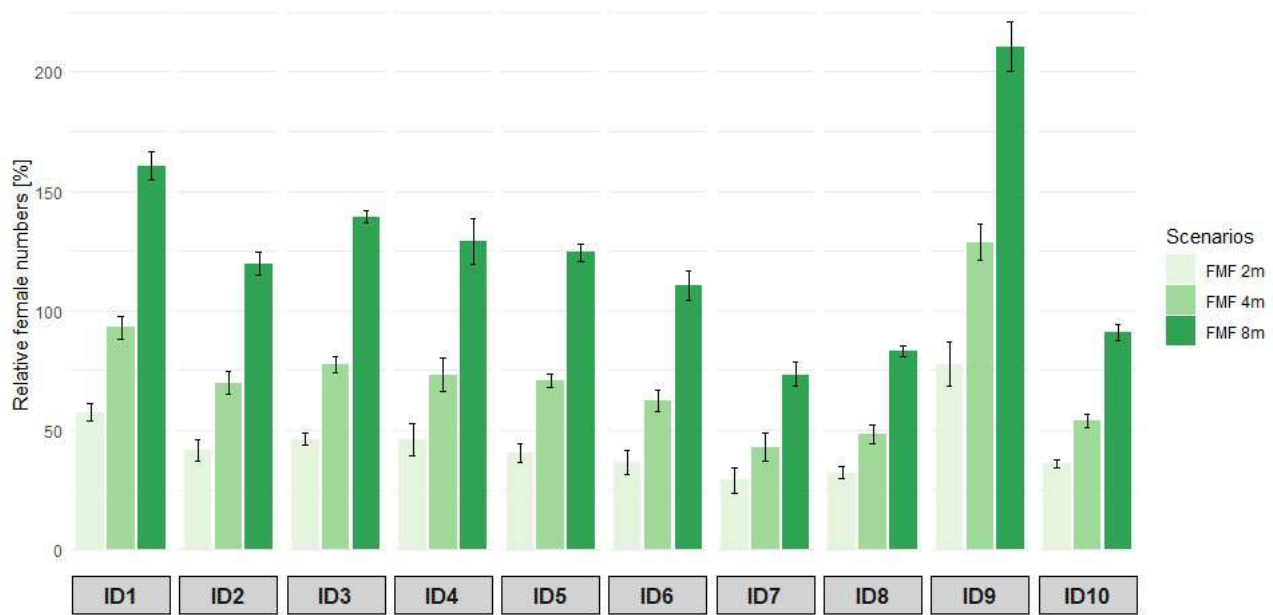


Figure 4.25 Flower field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

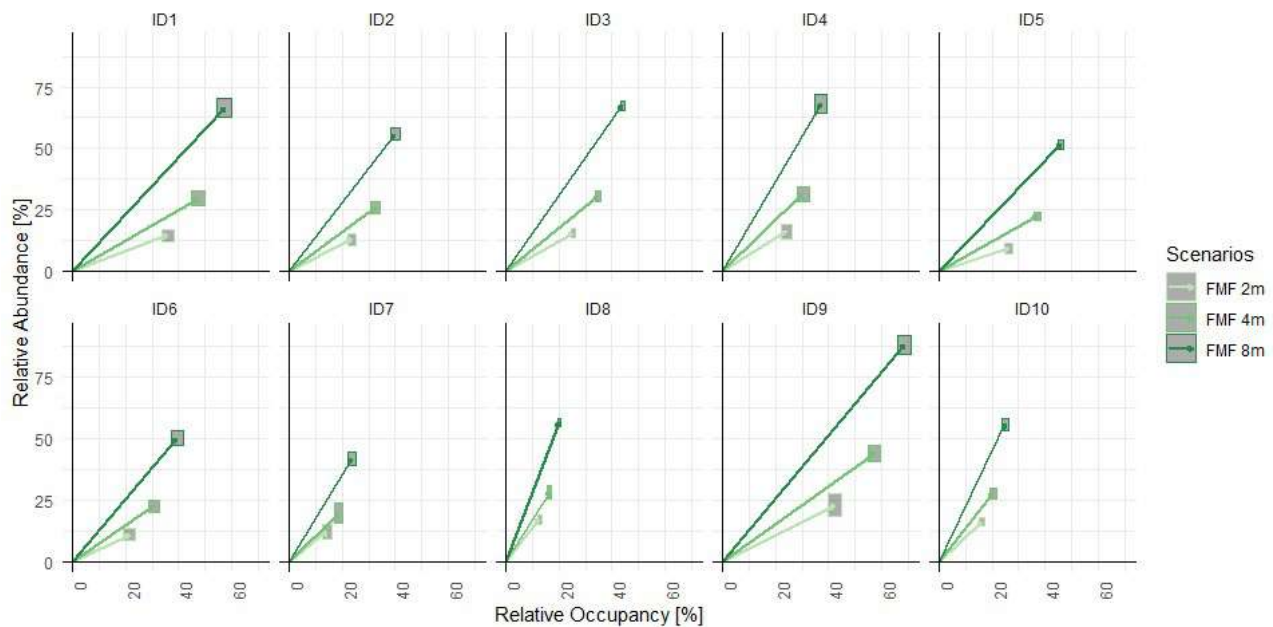


Figure 4.26 Flower field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.3 Grassy field margins

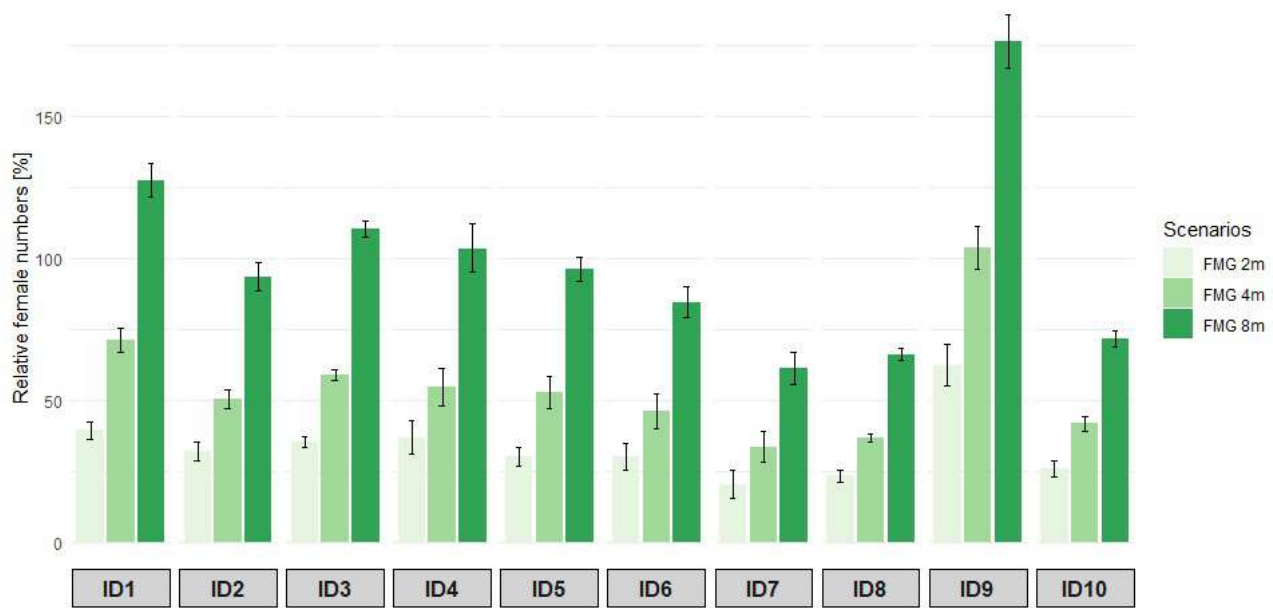


Figure 4.27 Grassy field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

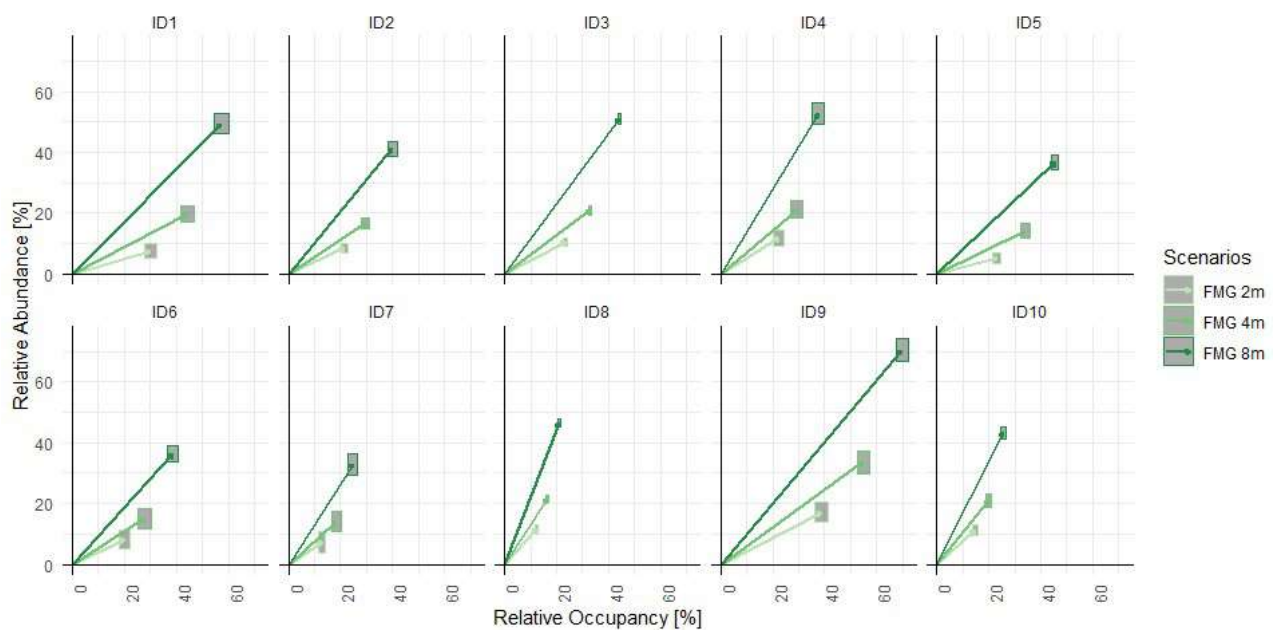


Figure 4.28 Grassy field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.4 Mixed field margins

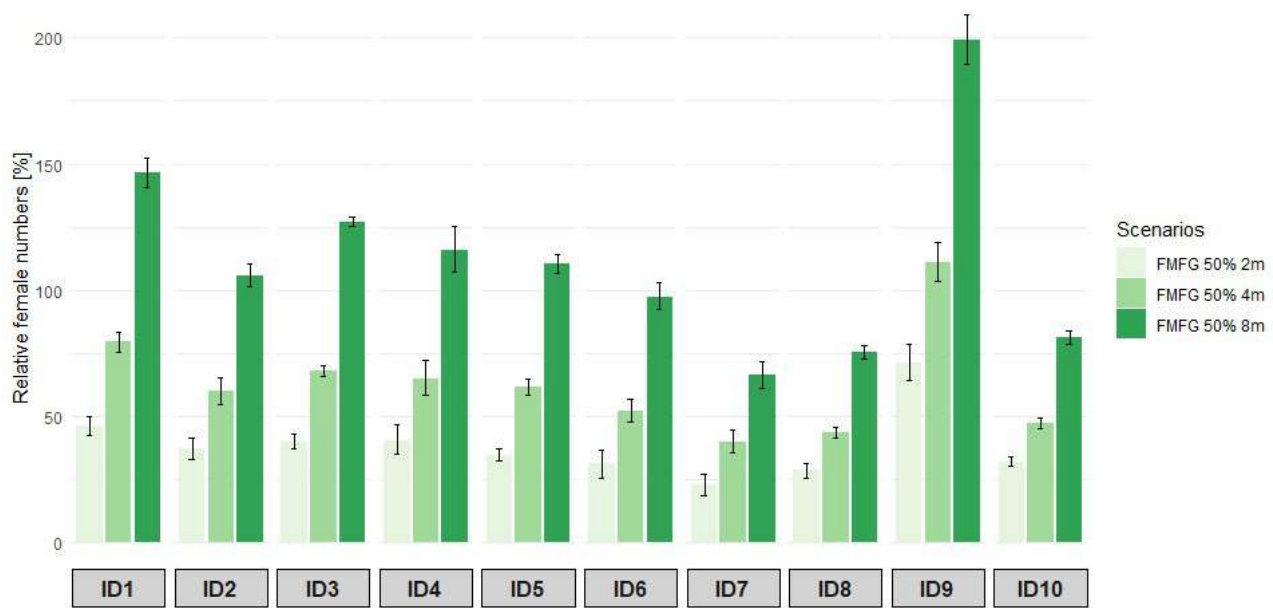


Figure 4.29 Mixed field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

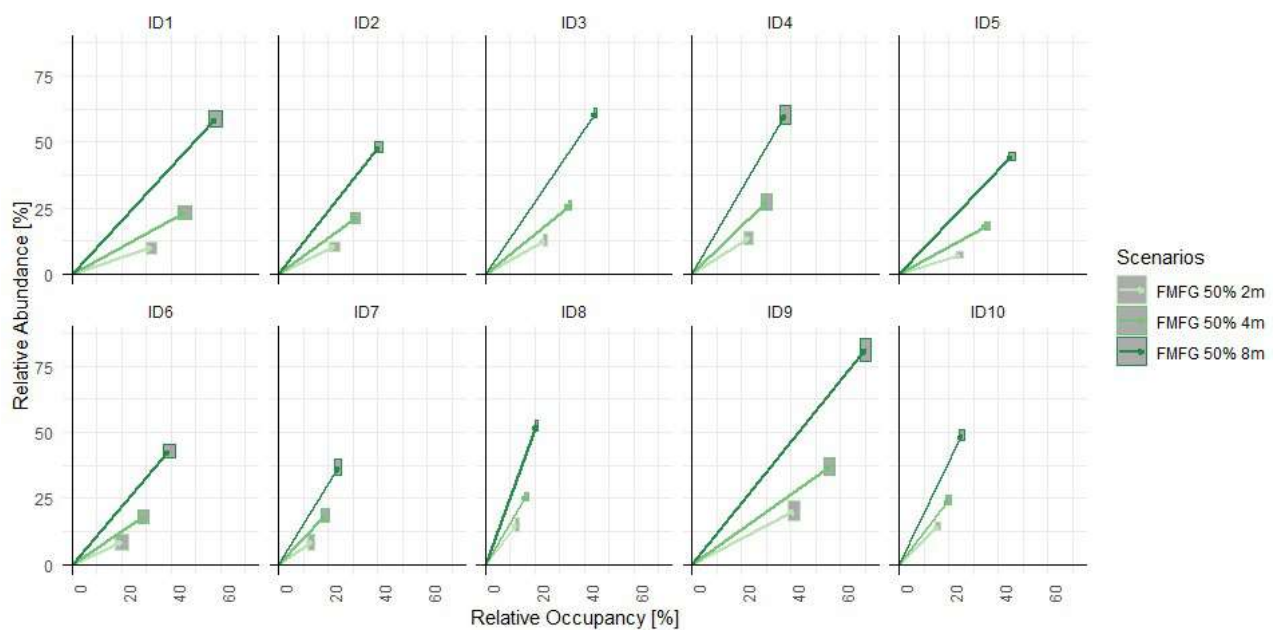


Figure 4.30 Mixed field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.5 Flower, grassy and mixed field margins

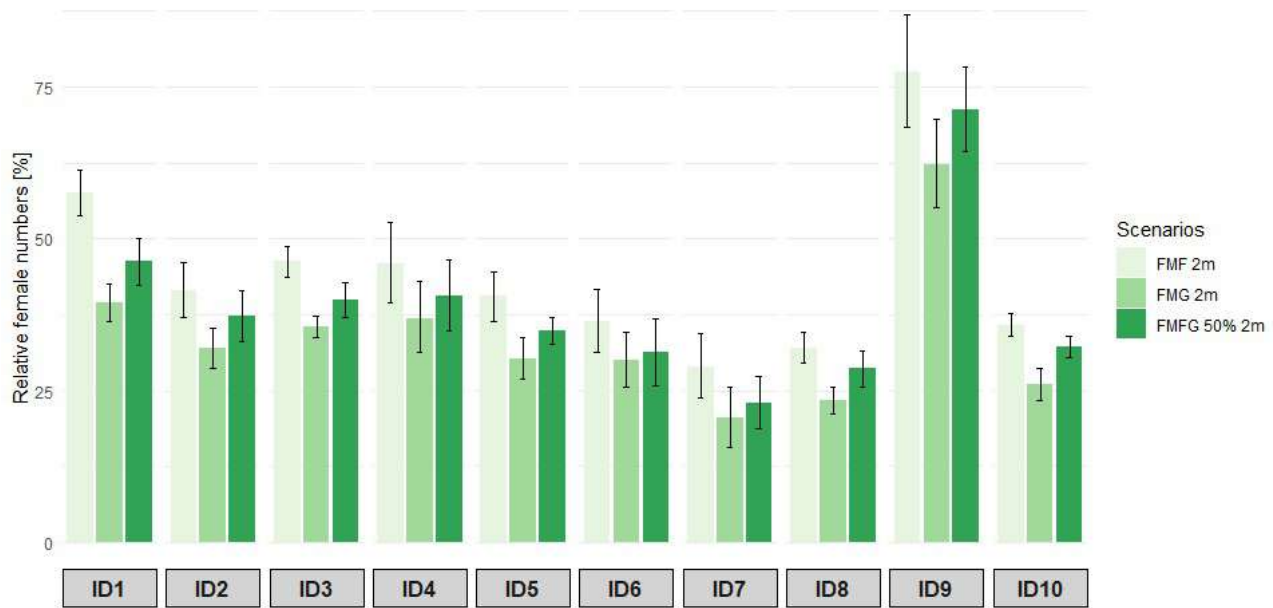


Figure 4.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

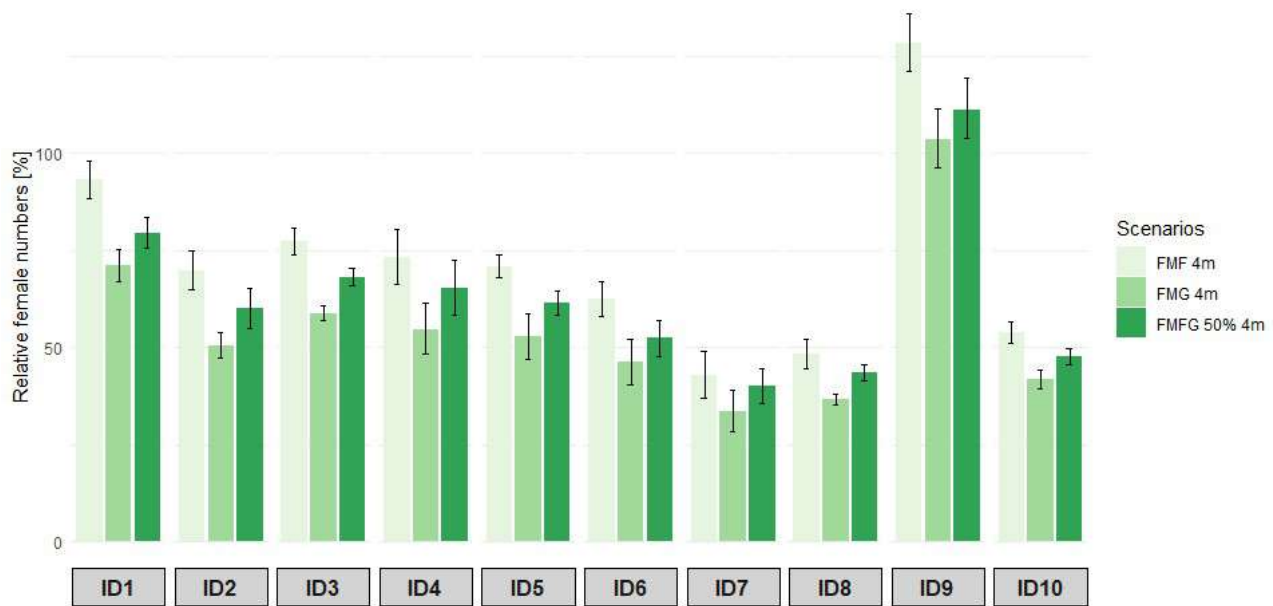


Figure 4.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

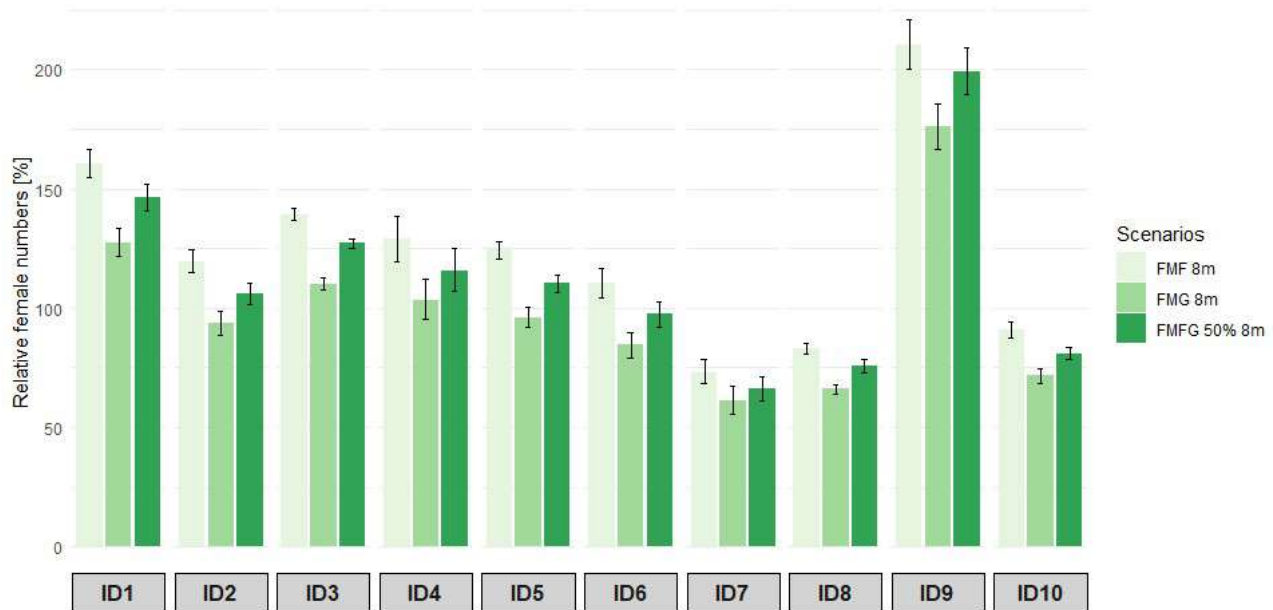


Figure 4.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

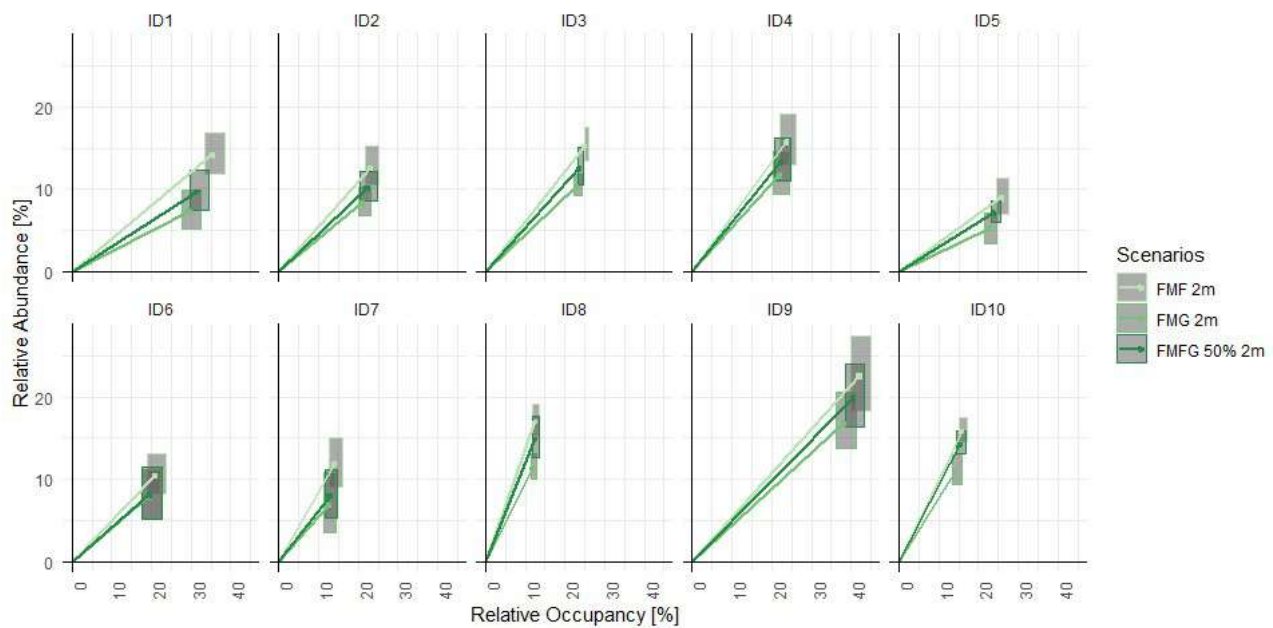


Figure 4.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

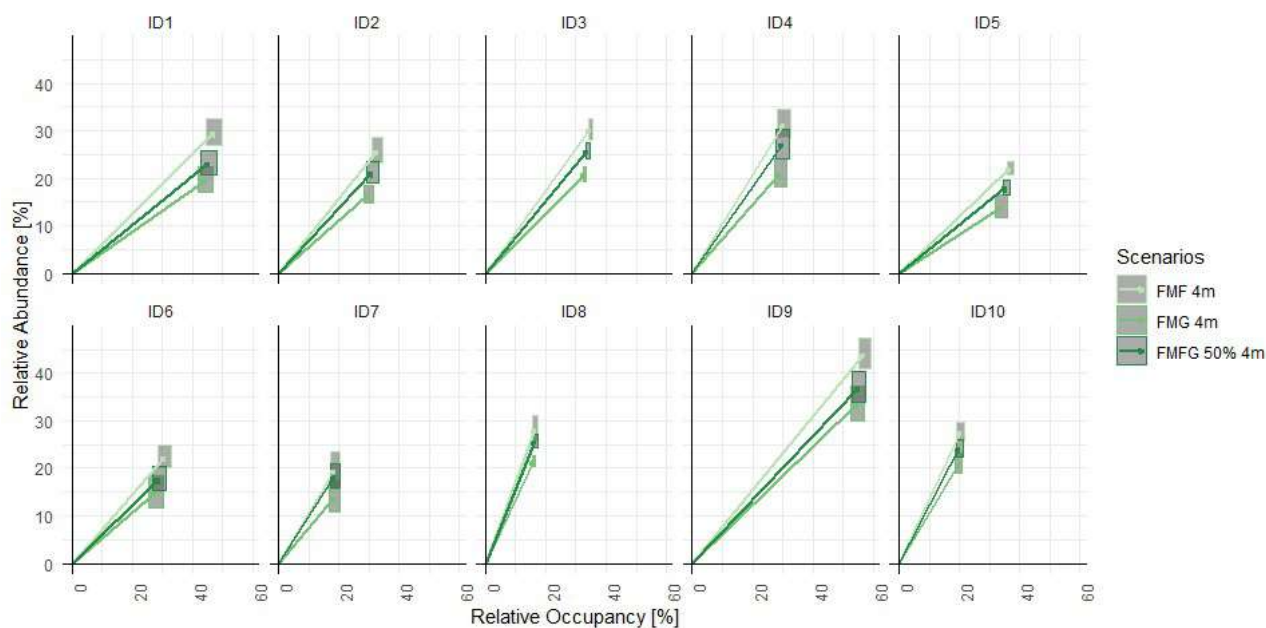


Figure 4.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes..

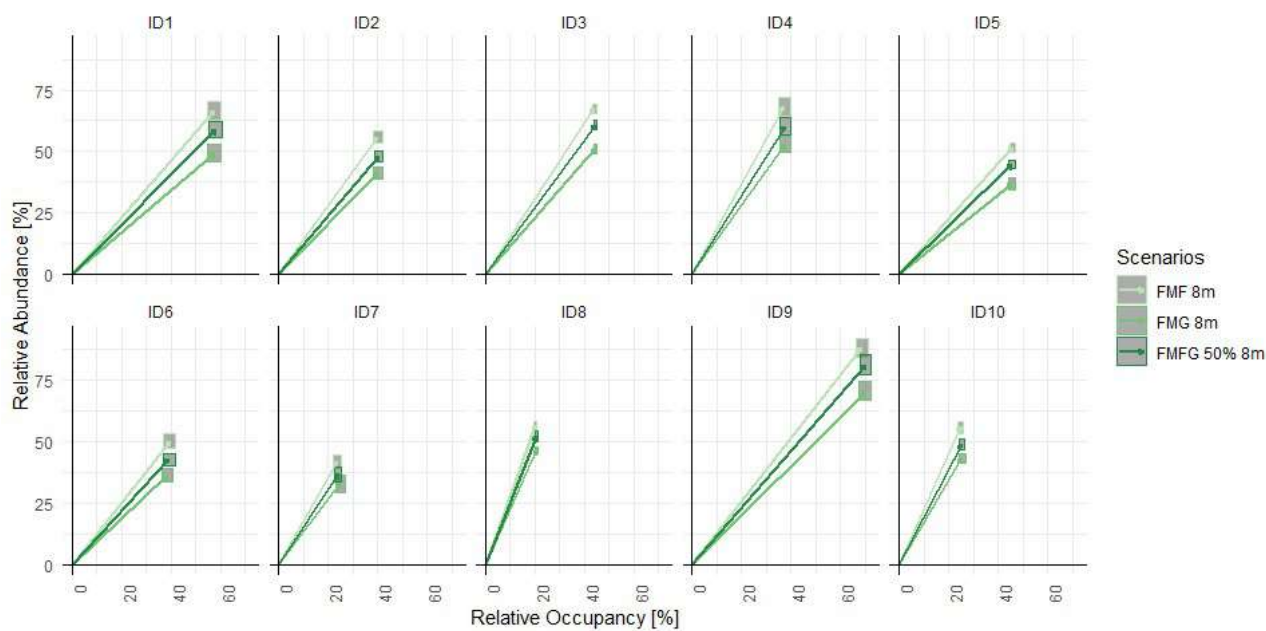


Figure 4.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.6 Setaside

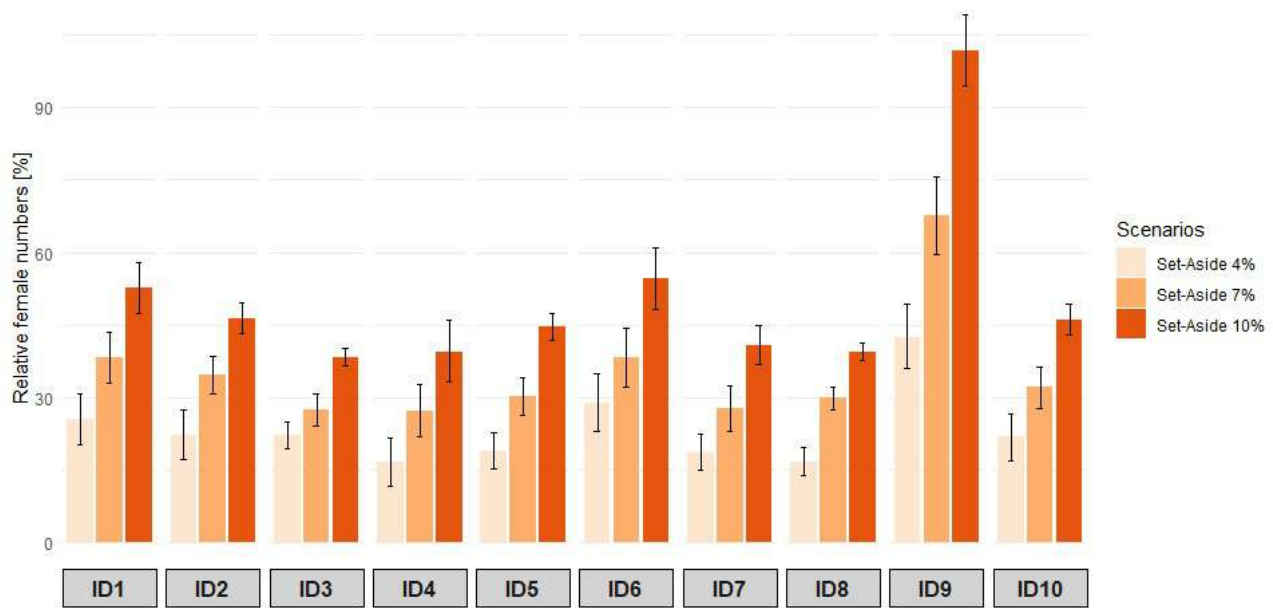


Figure 4.37 Setaside scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

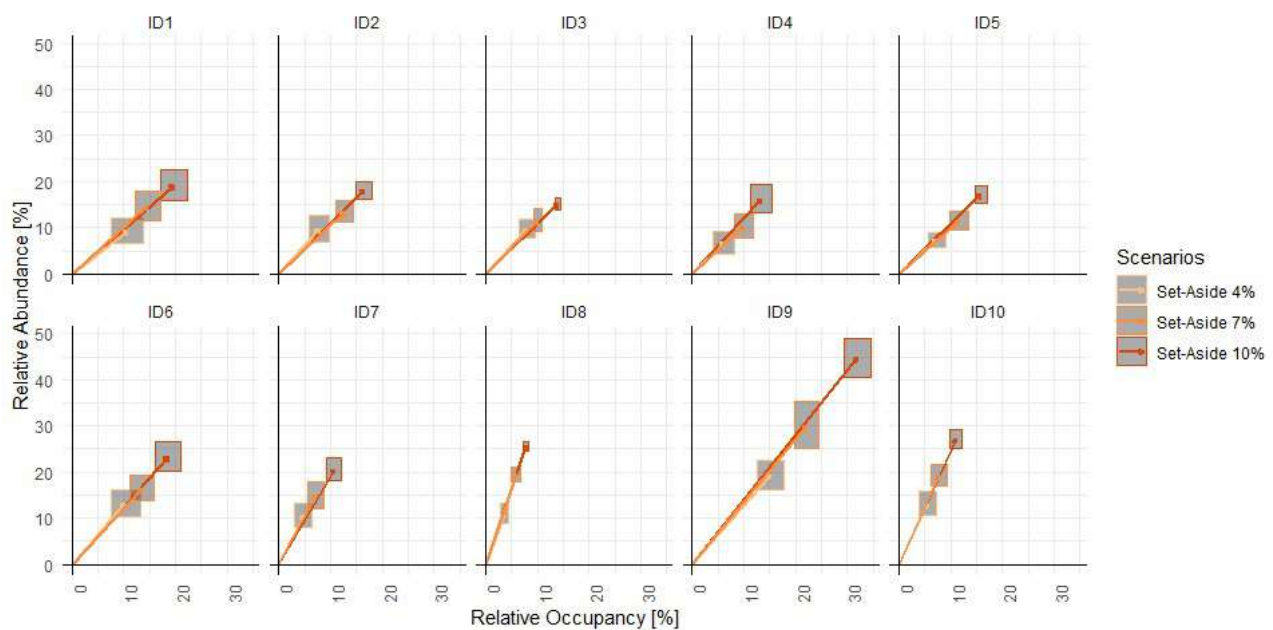


Figure 4.38 Setaside scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.7 Legume

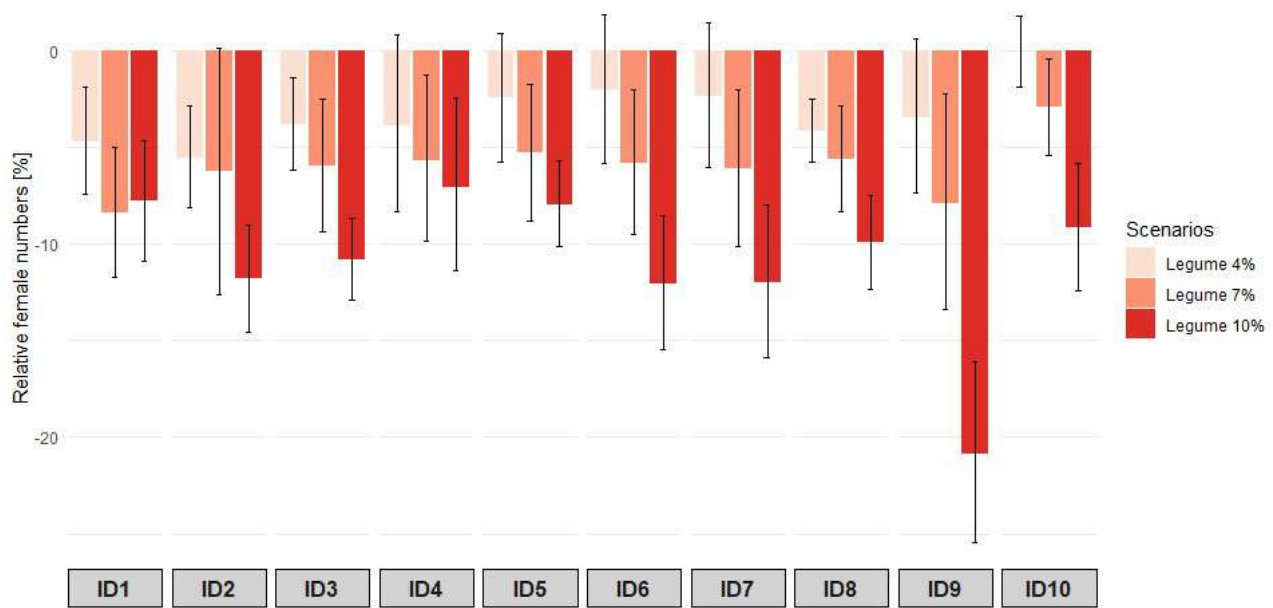


Figure 4.39 Legume scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

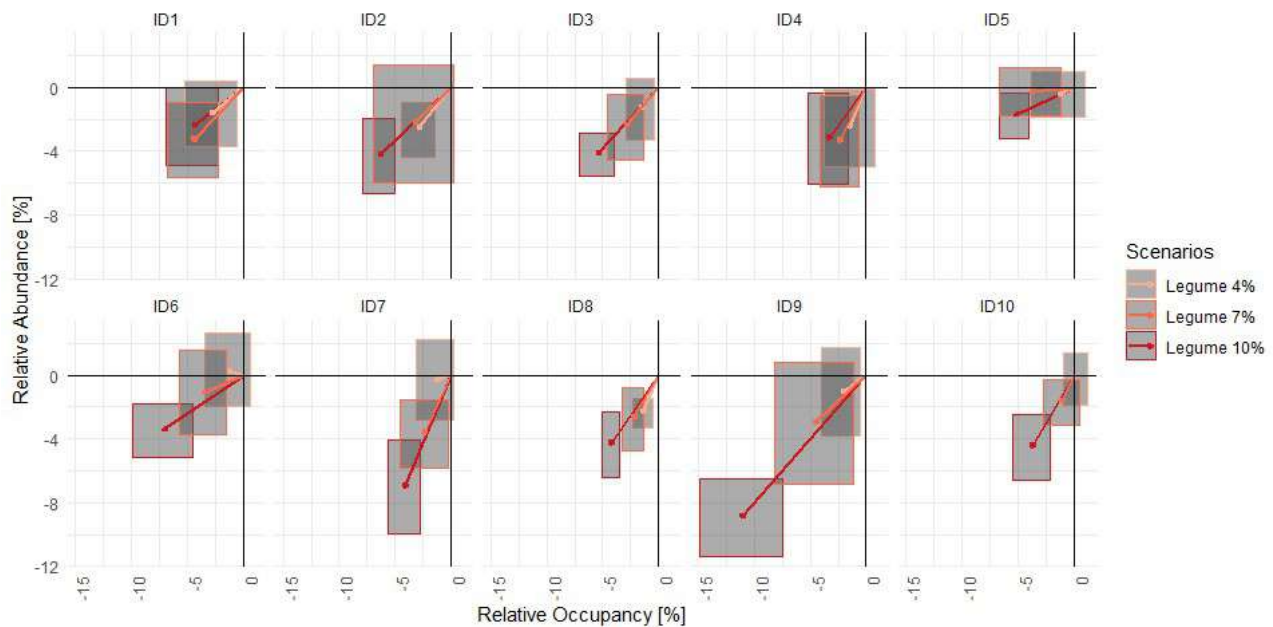


Figure 4.40 Legume scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.3.8 Biopesticides

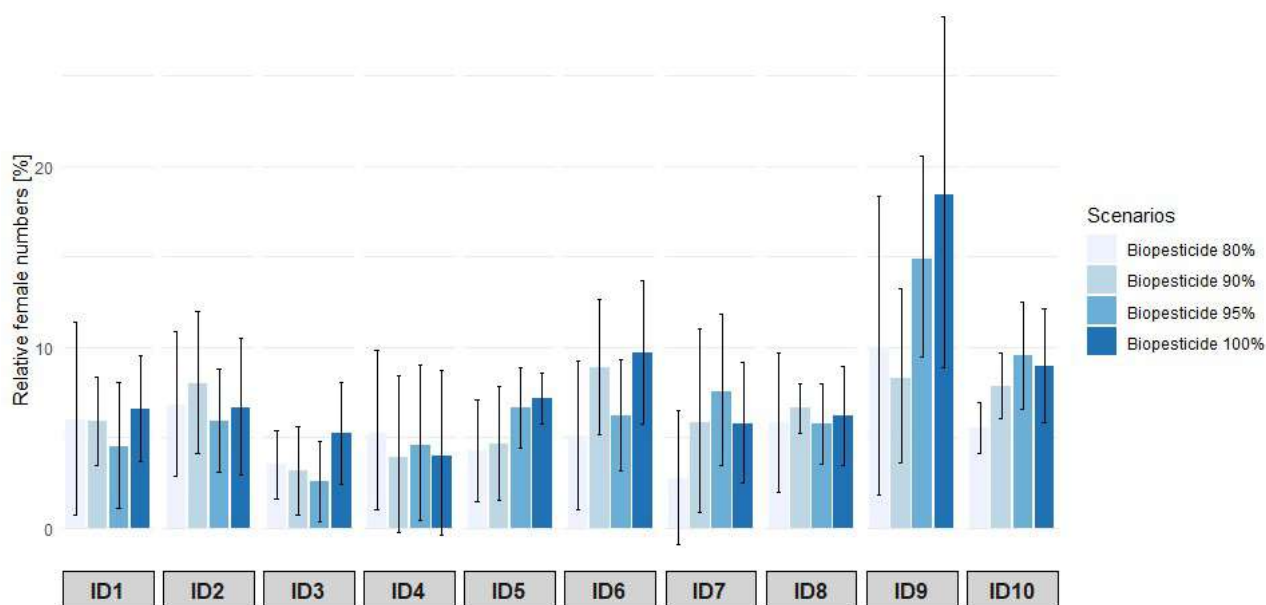


Figure 4.41 Biopesticide scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

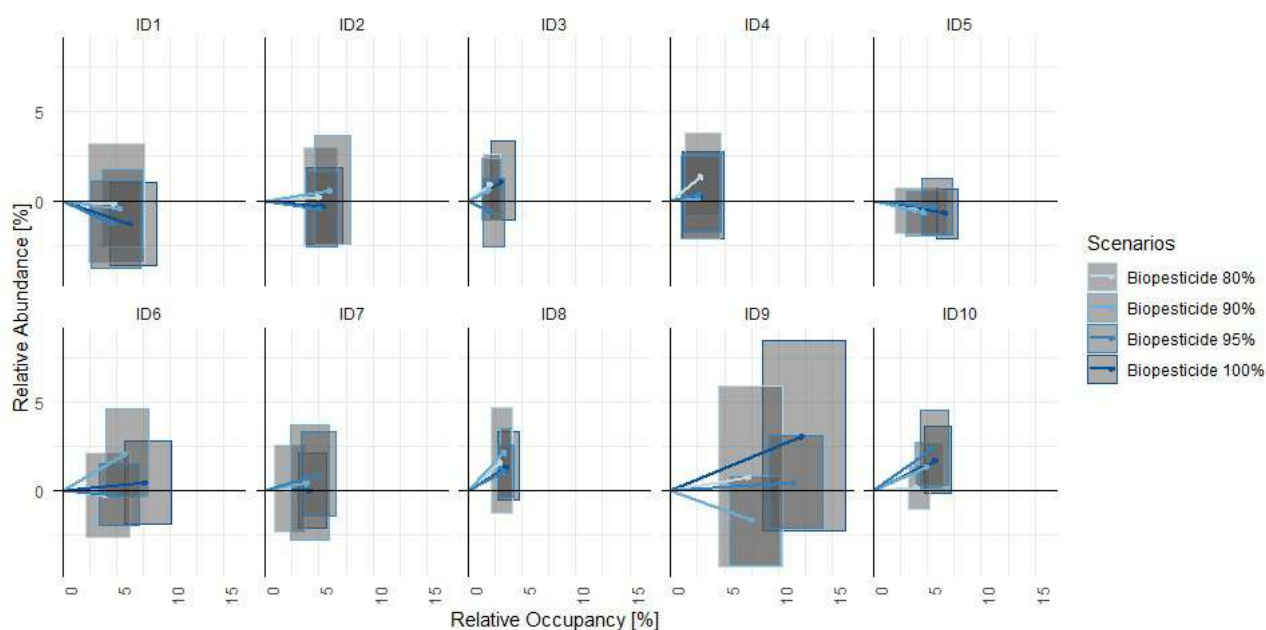


Figure 4.42 Biopesticide scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4 Poland

4.4.1 Flower field margins

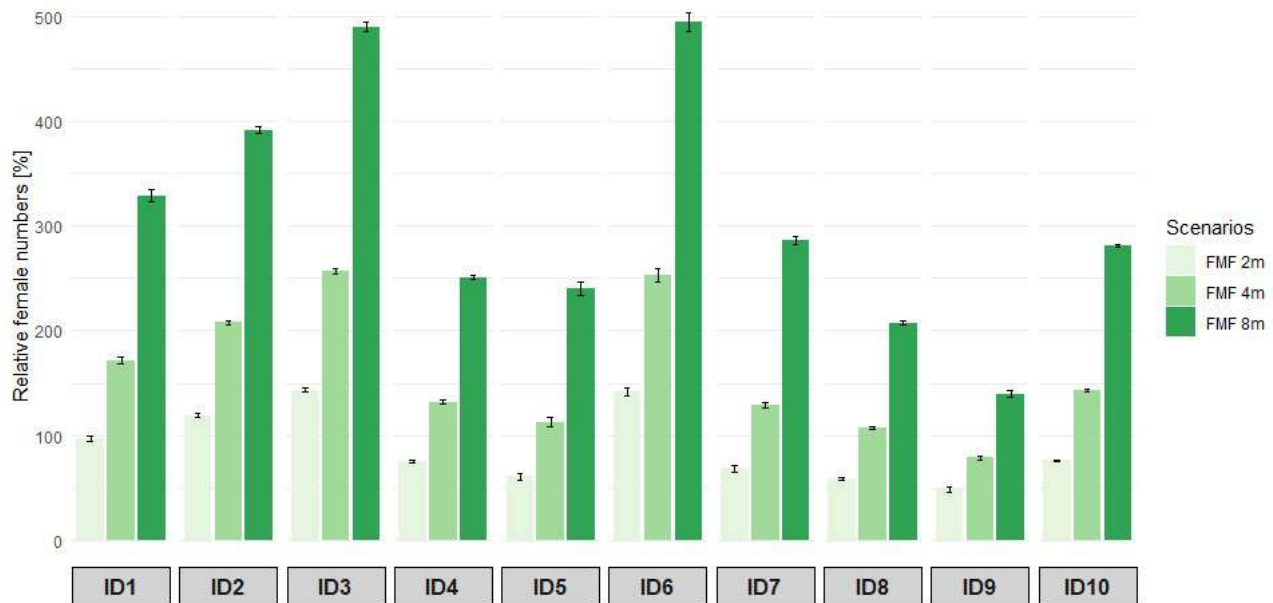


Figure 4.43 Flower field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

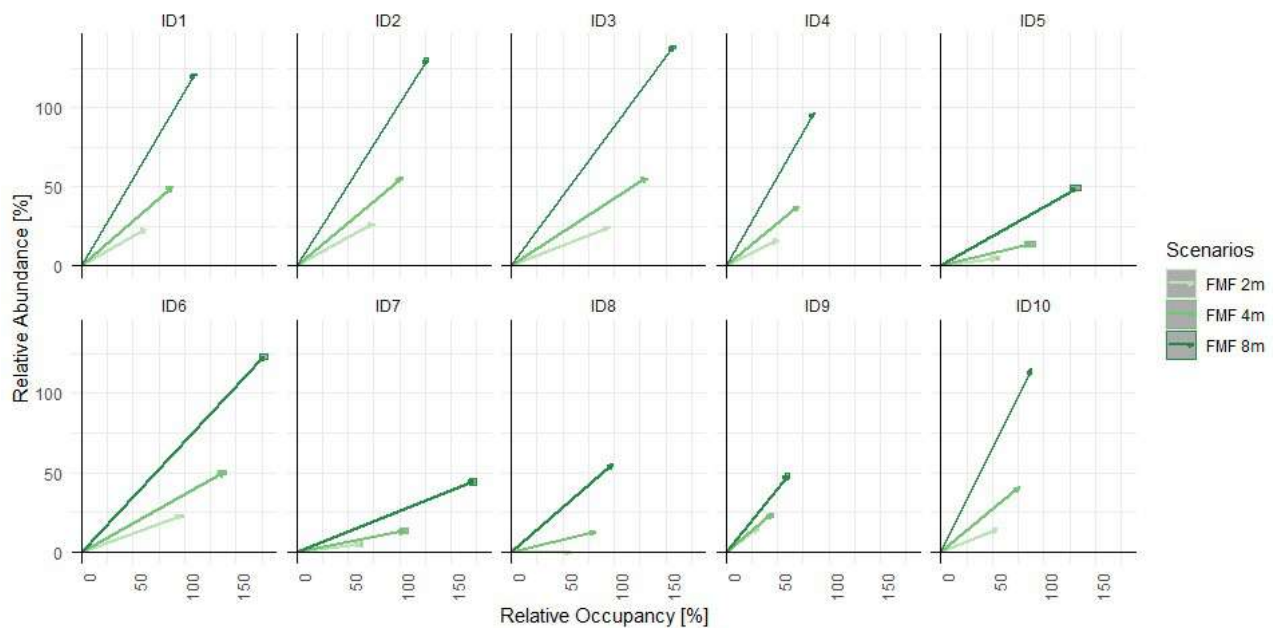


Figure 4.44 Flower field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4.2 Grassy field margins

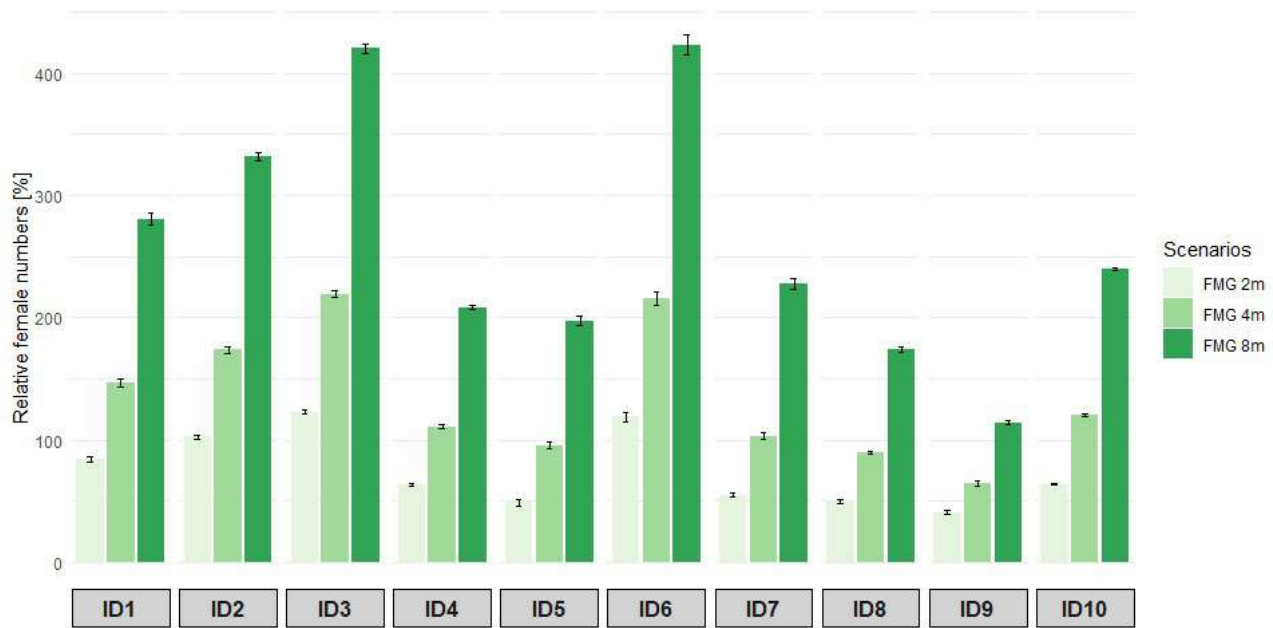


Figure 4.45 Grassy field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

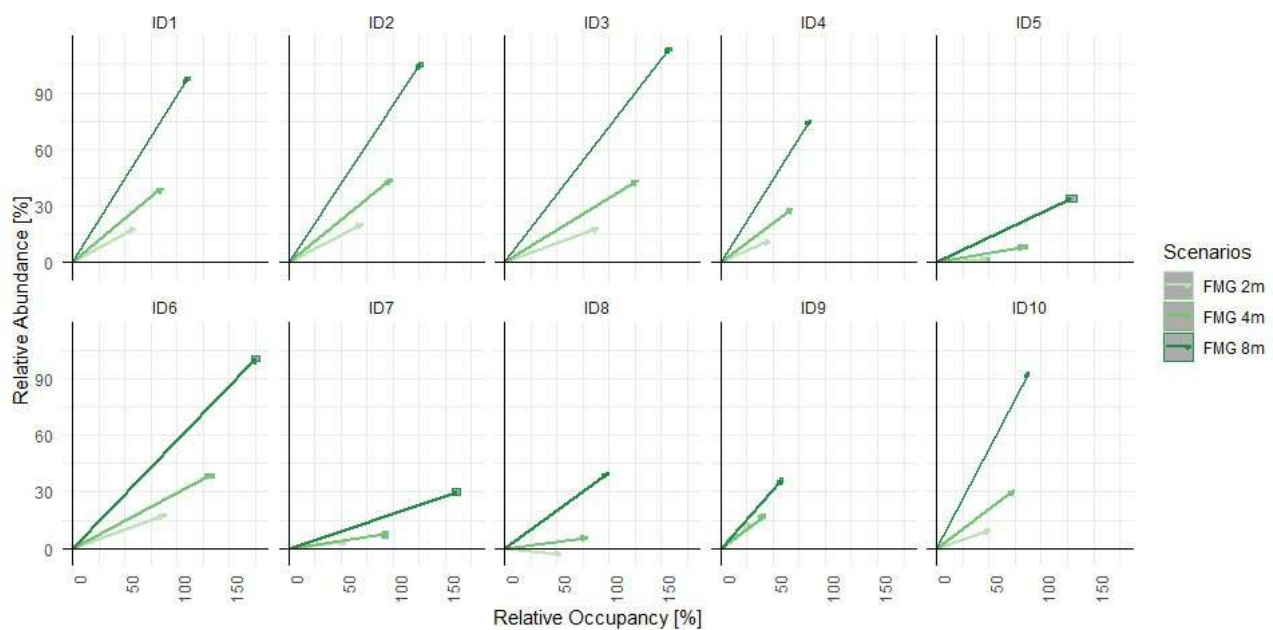


Figure 4.46 Grassy field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4.3 Mixed field margins

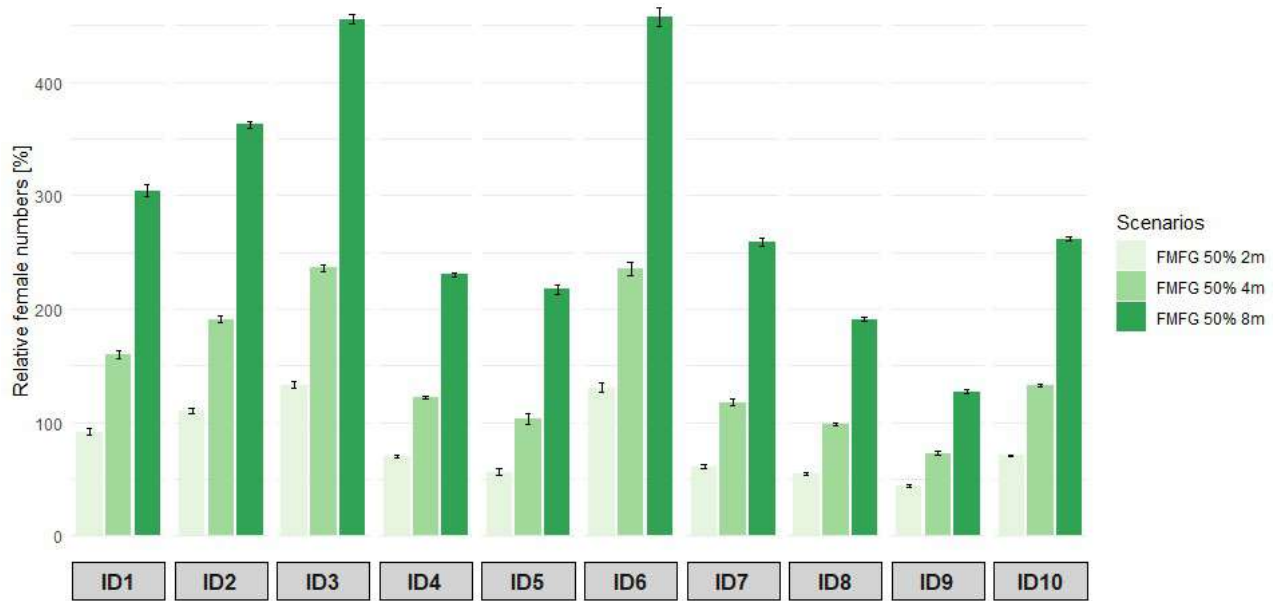


Figure 4.47 Mixed field margins scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

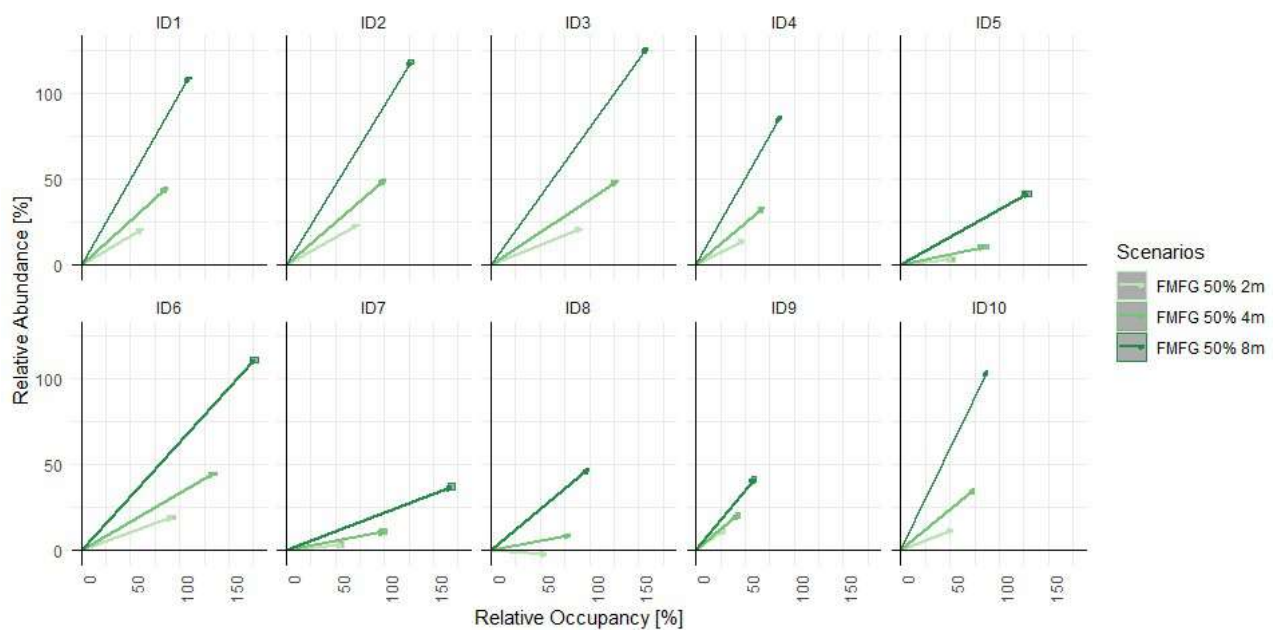


Figure 4.48 Mixed field margins with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4.4 Flower, grassy and mixed field margins

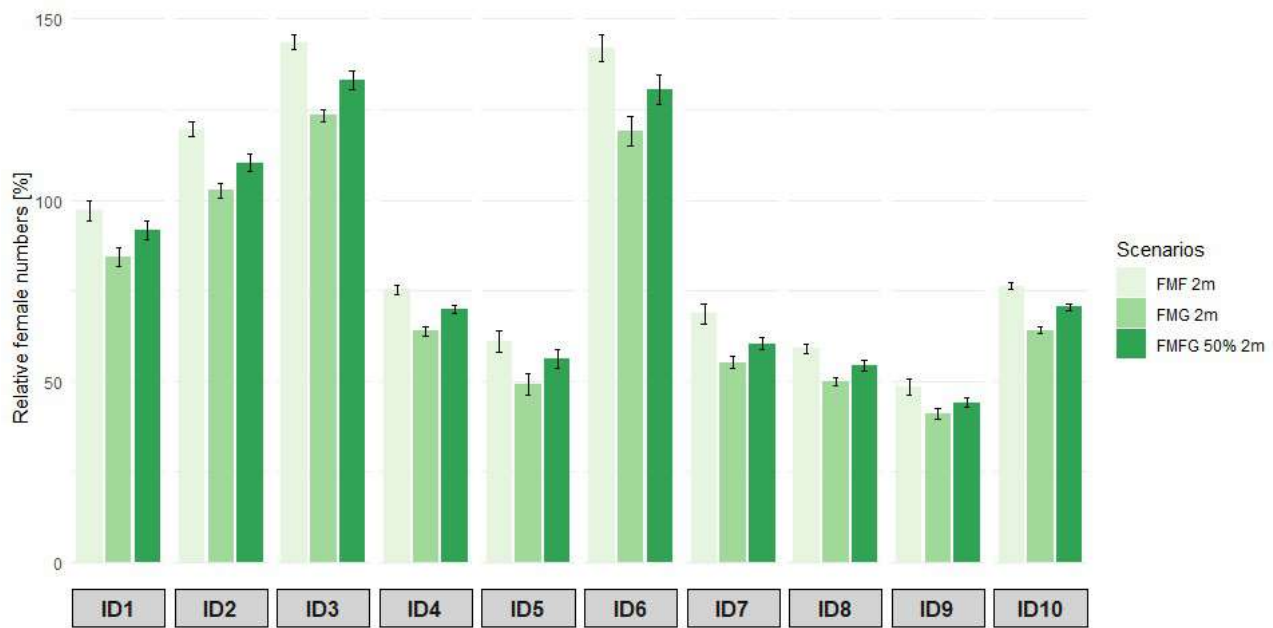


Figure 4.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

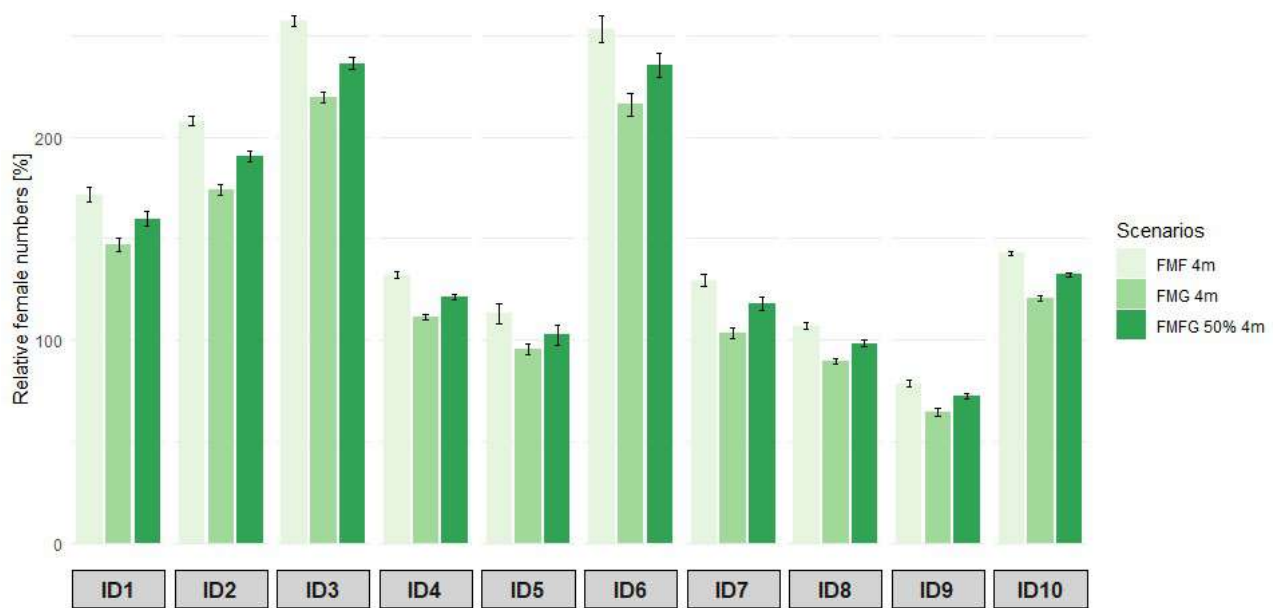


Figure 4.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

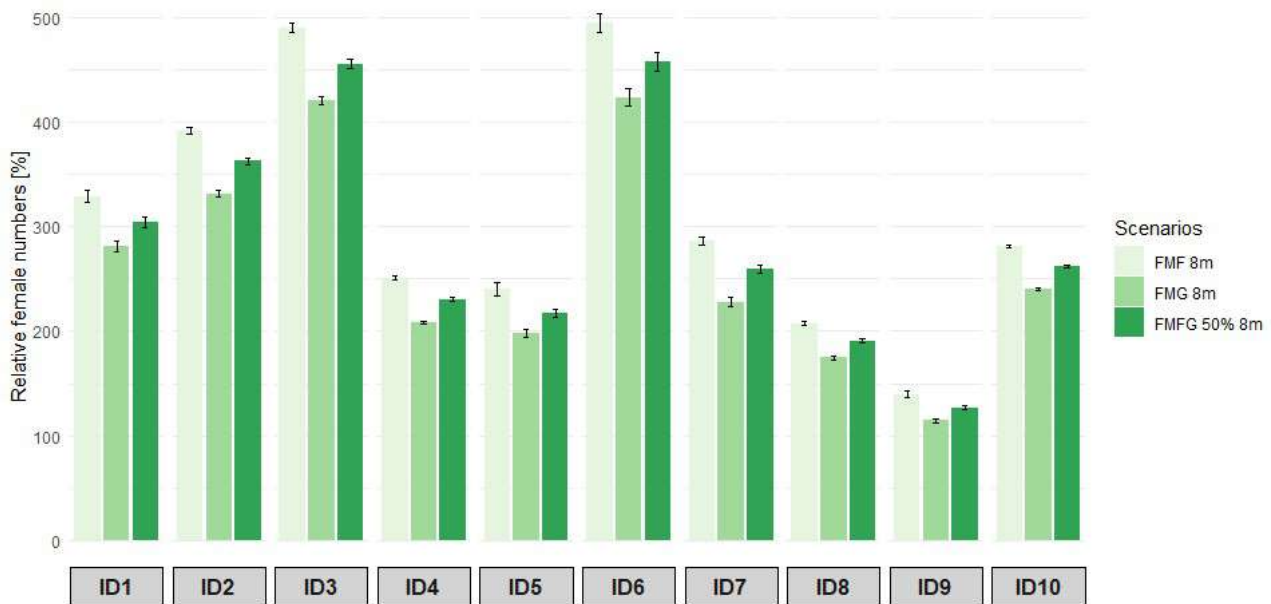


Figure 4.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

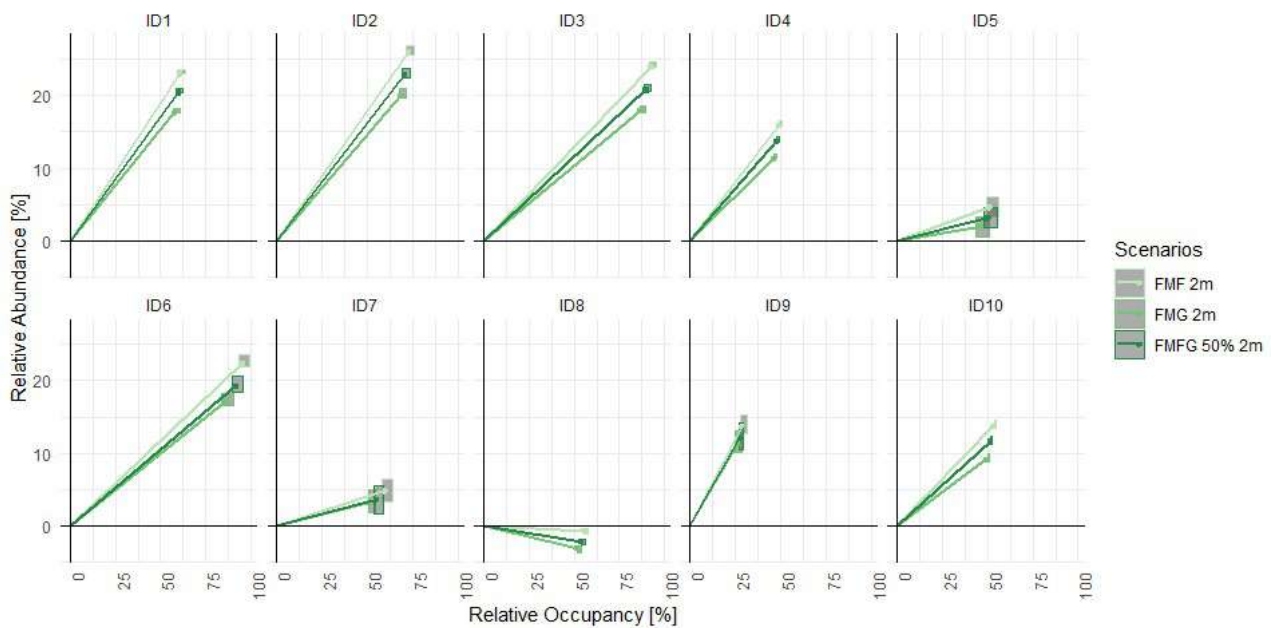


Figure 4.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

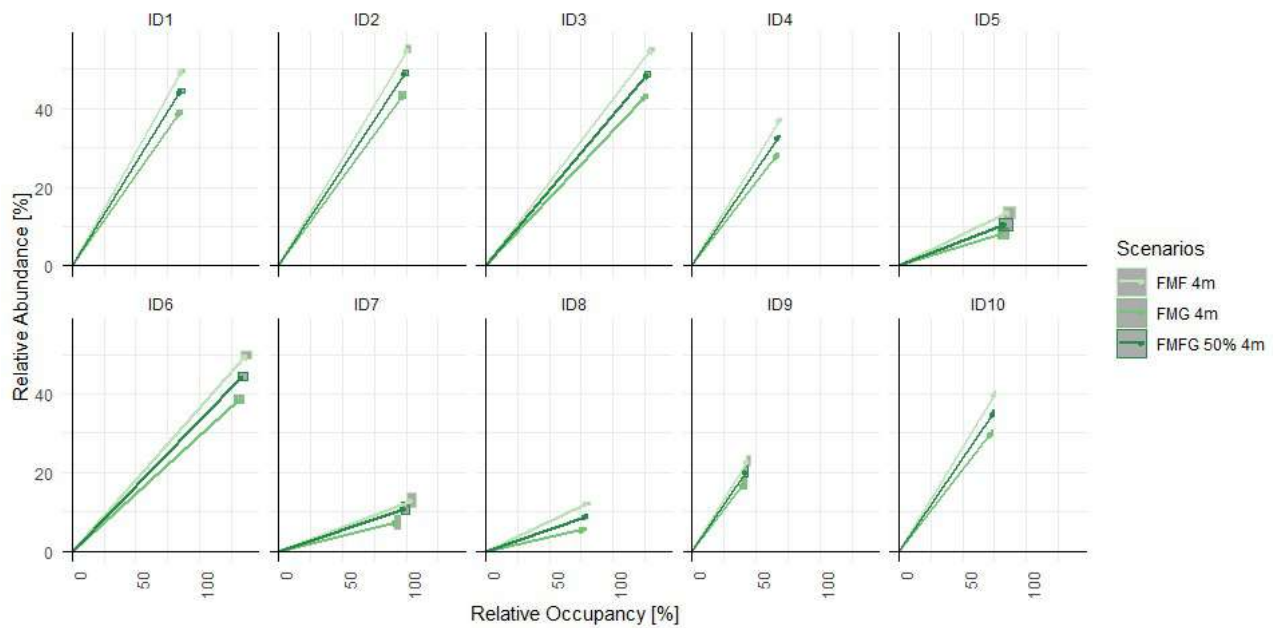


Figure 4.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes..

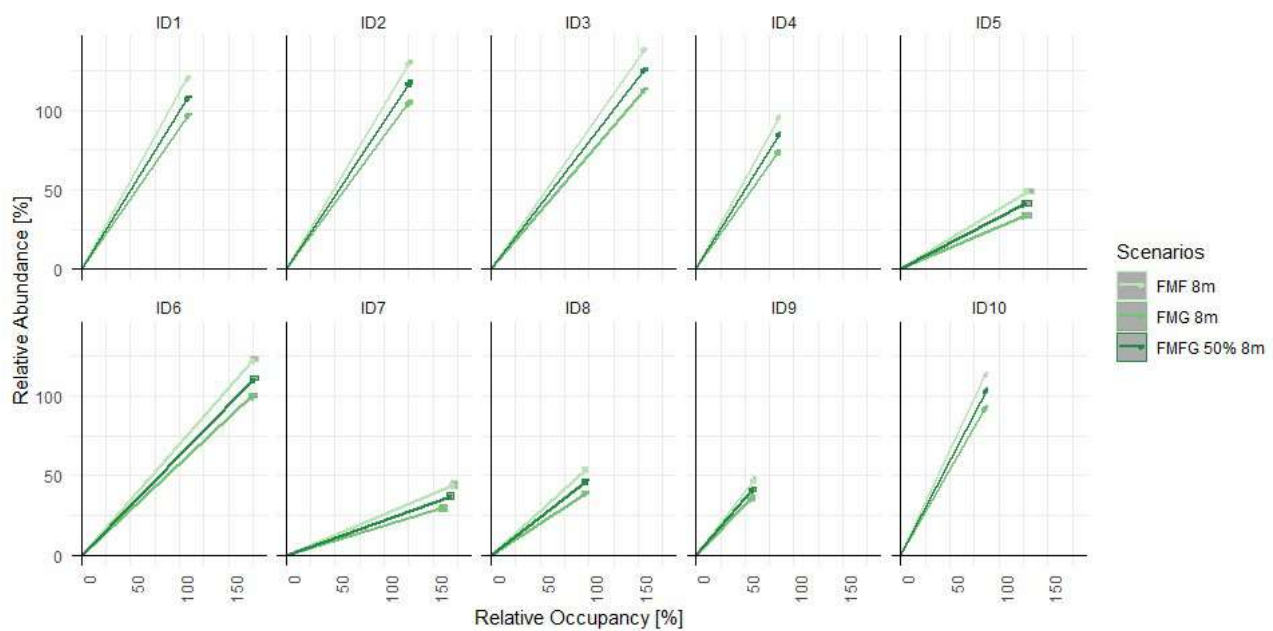


Figure 4.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4.5 Setaside

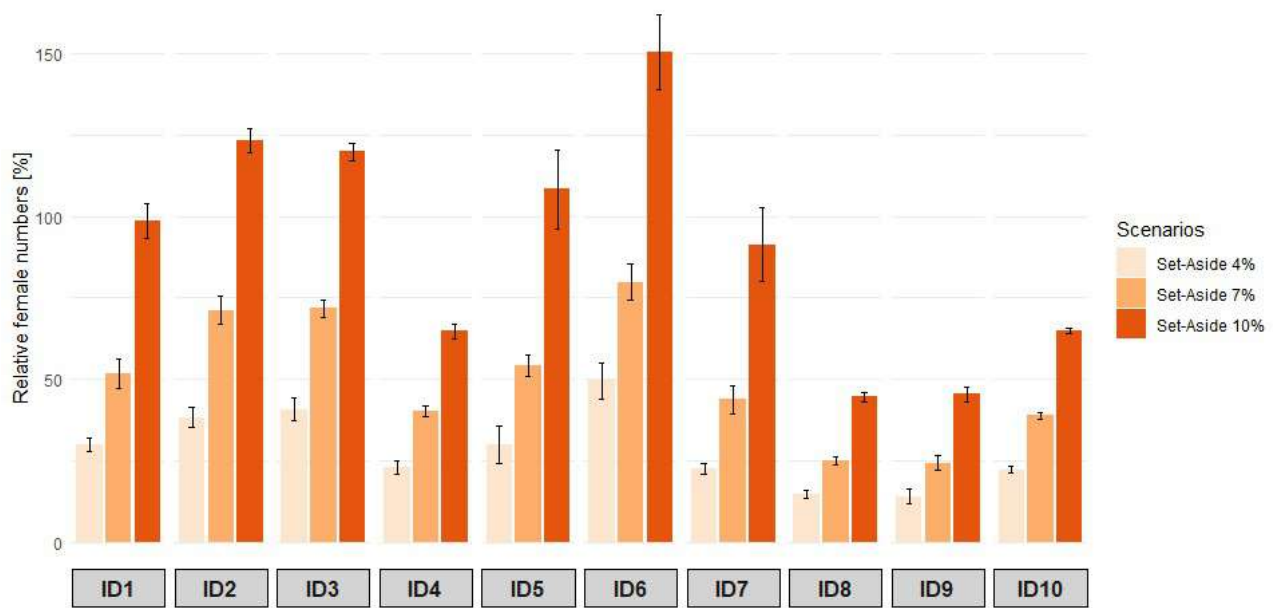


Figure 4.55 Setaside scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

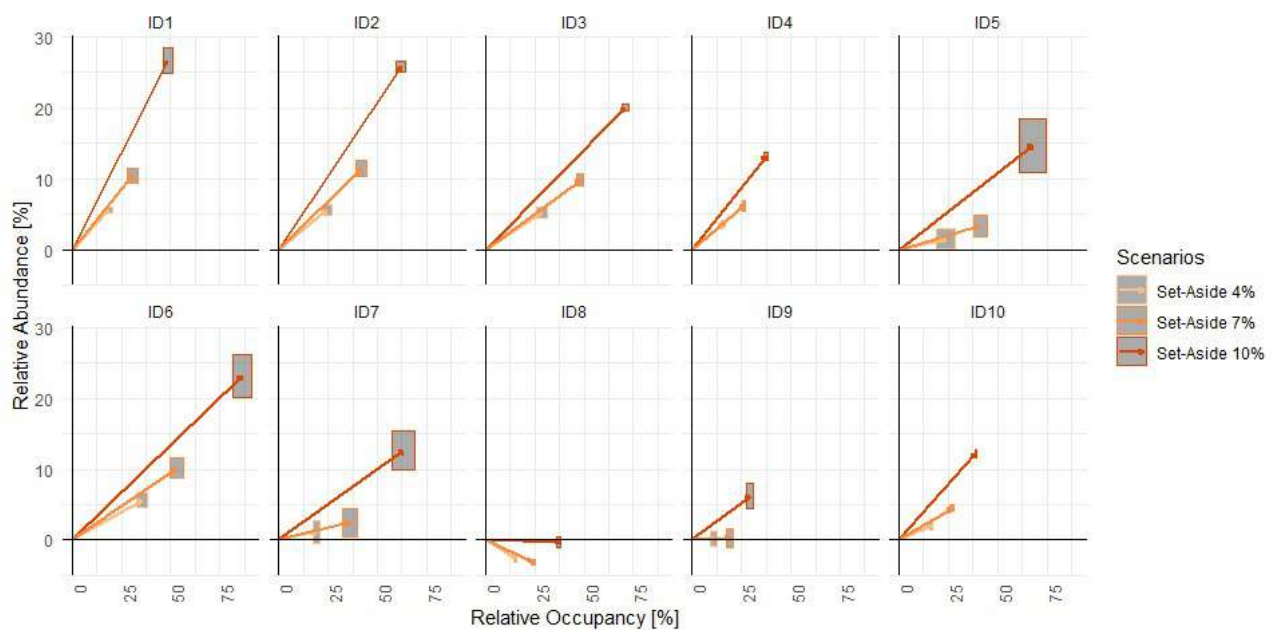


Figure 4.56 Setaside scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4.6 Legume

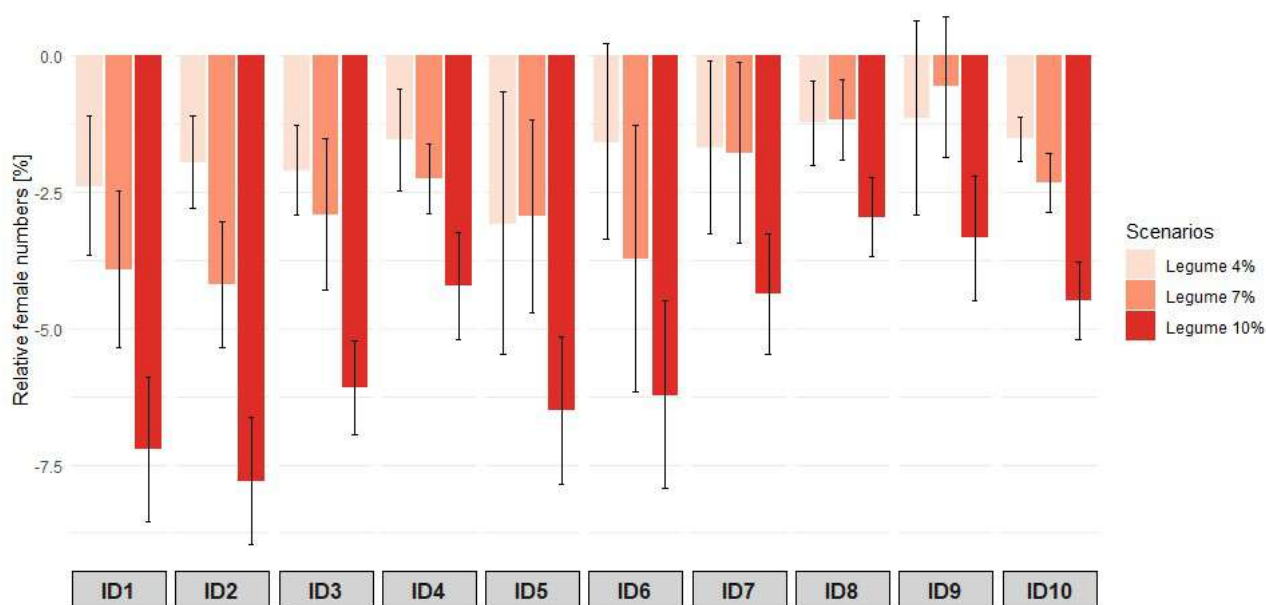


Figure 4.57 Legume scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

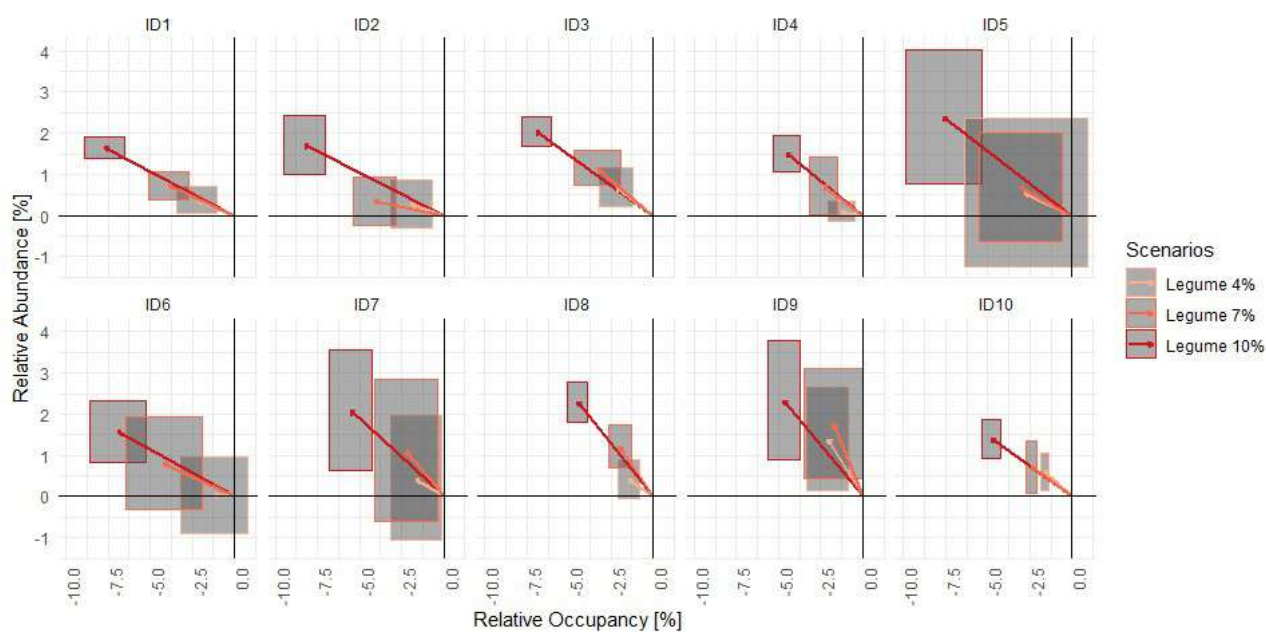


Figure 4.58 Legume scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.4.7 Biopesticides

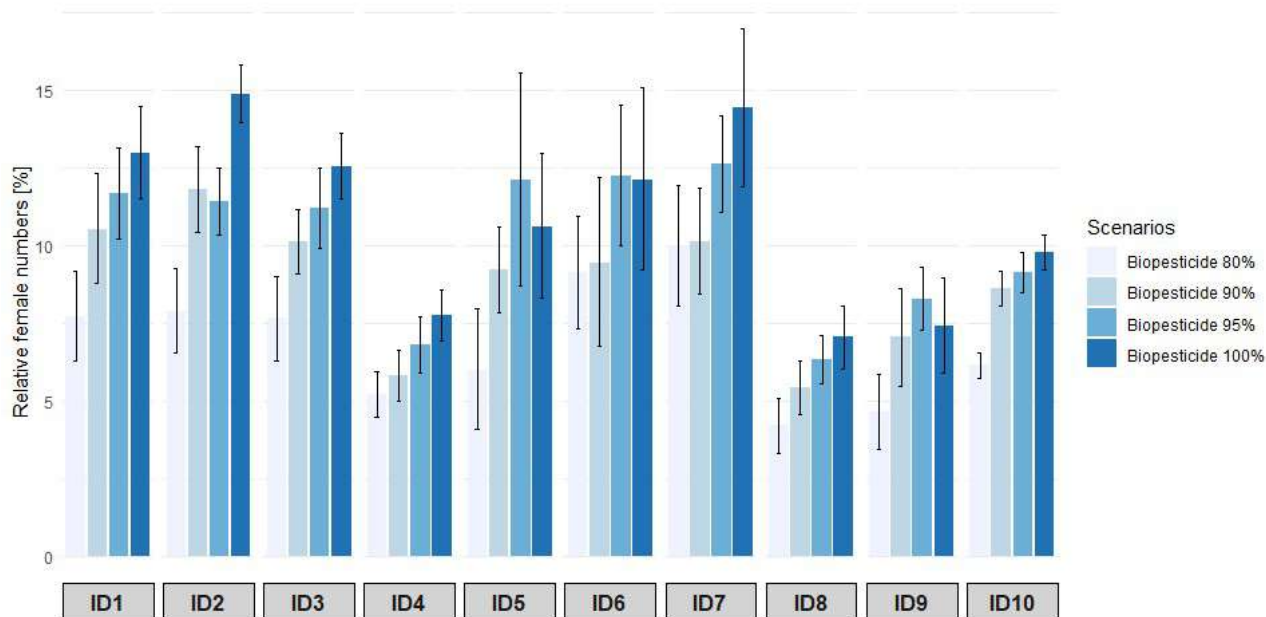


Figure 4.59 Biopesticide scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

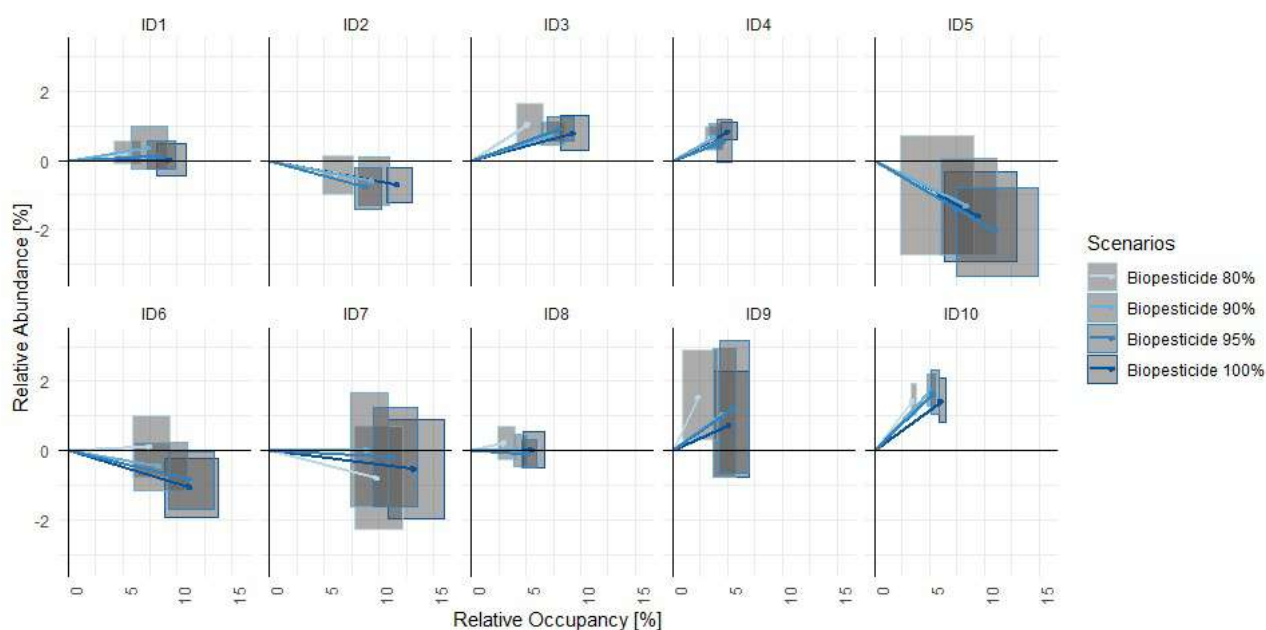


Figure 4.60 Biopesticide scenario with relative change in occupancy and abundance of female *Oedothorax* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

4.5 Combined landscapes

4.5.1 Crop diversification

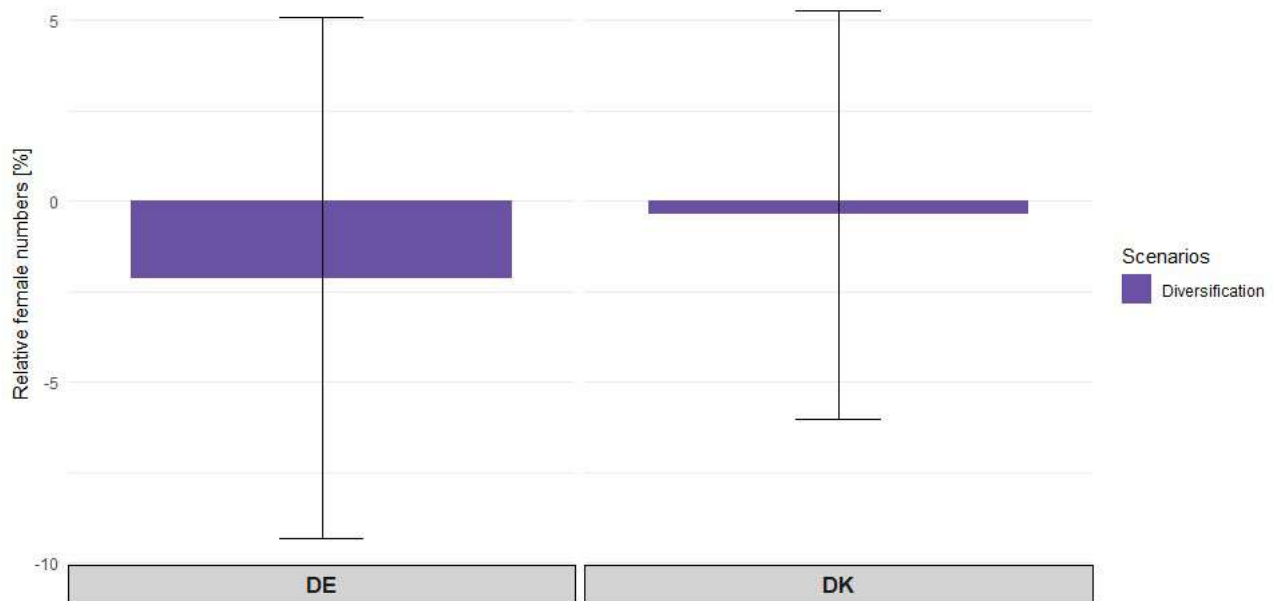


Figure 4.61 Diversification scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.2 Flower field margins

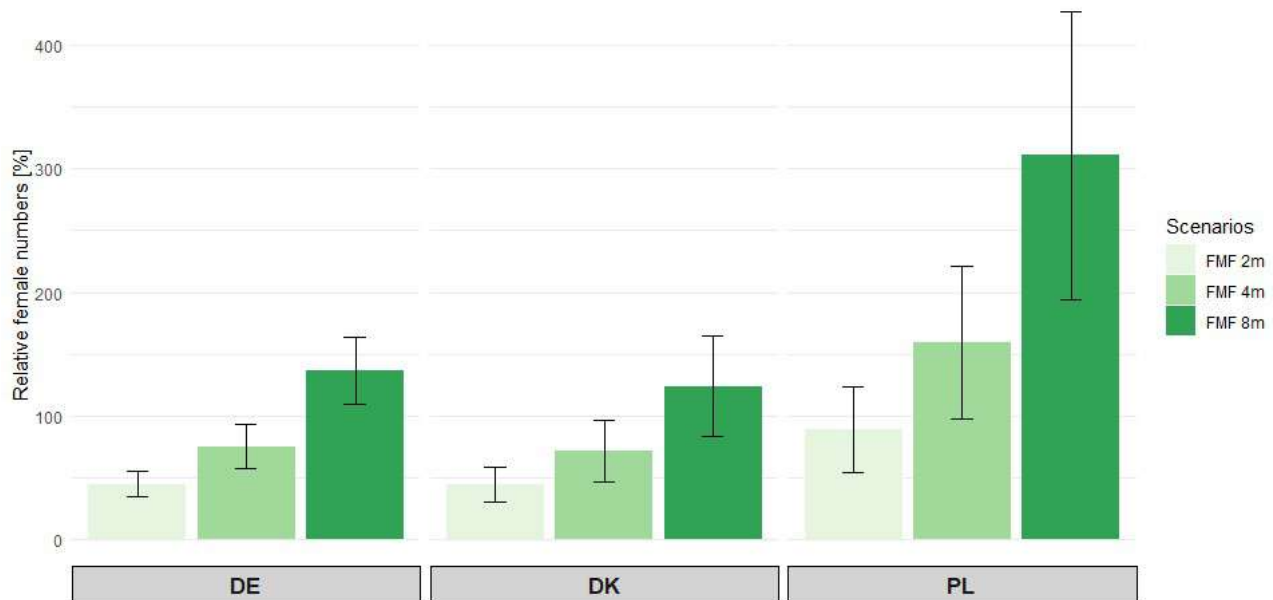


Figure 4.62 Flower field margins with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.3 Grassy field margins

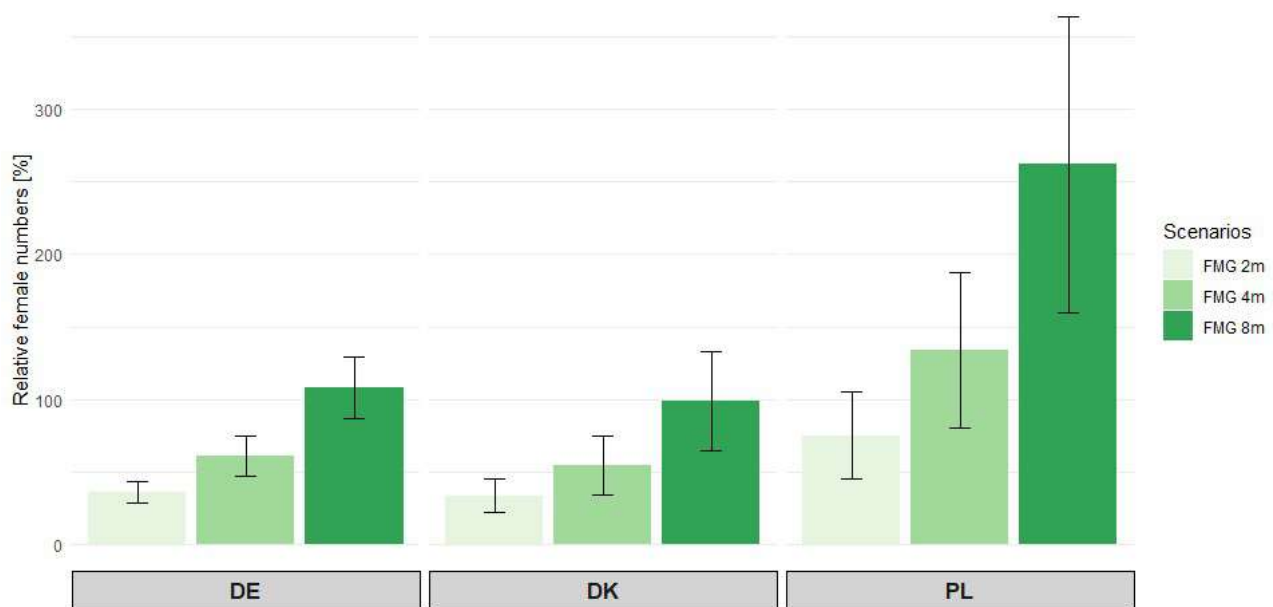


Figure 4.63 Grassy field margins with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.4 Mixed field margins

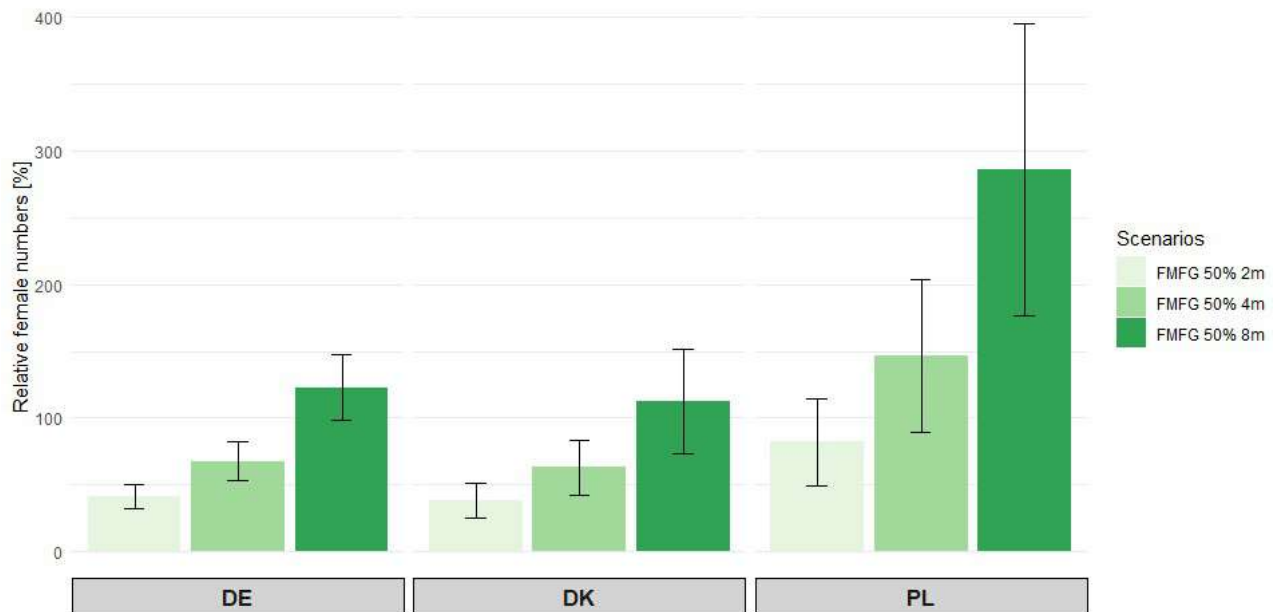


Figure 4.64 Mixed field margins with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.5 Flower, grassy and mixed margins

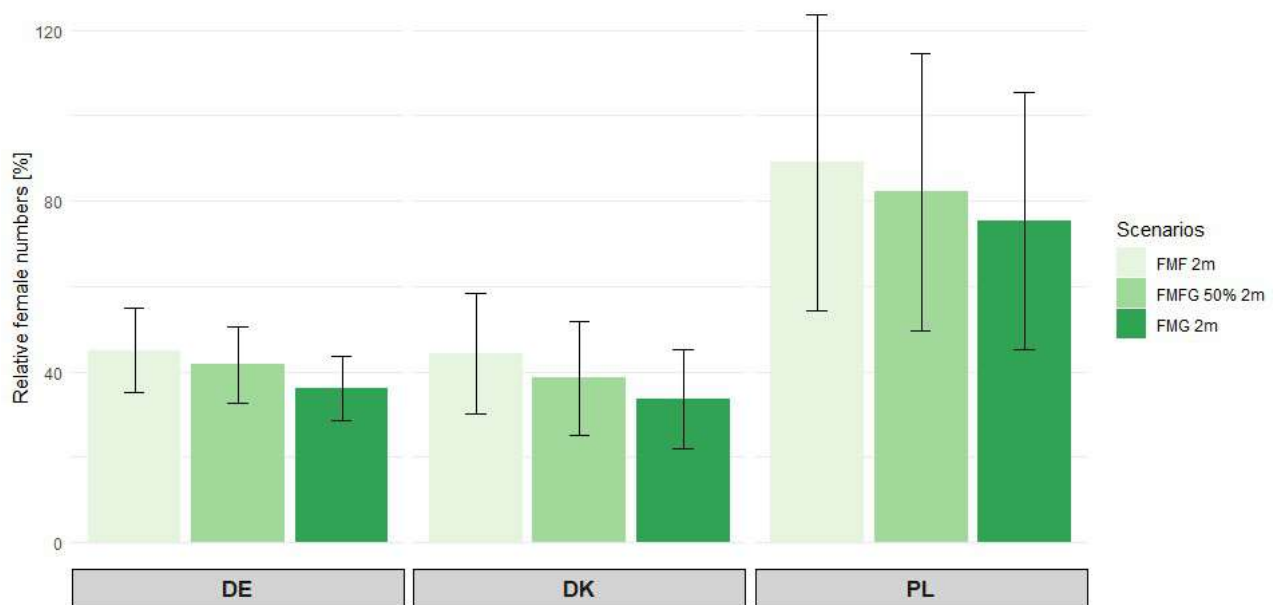


Figure 4.65 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

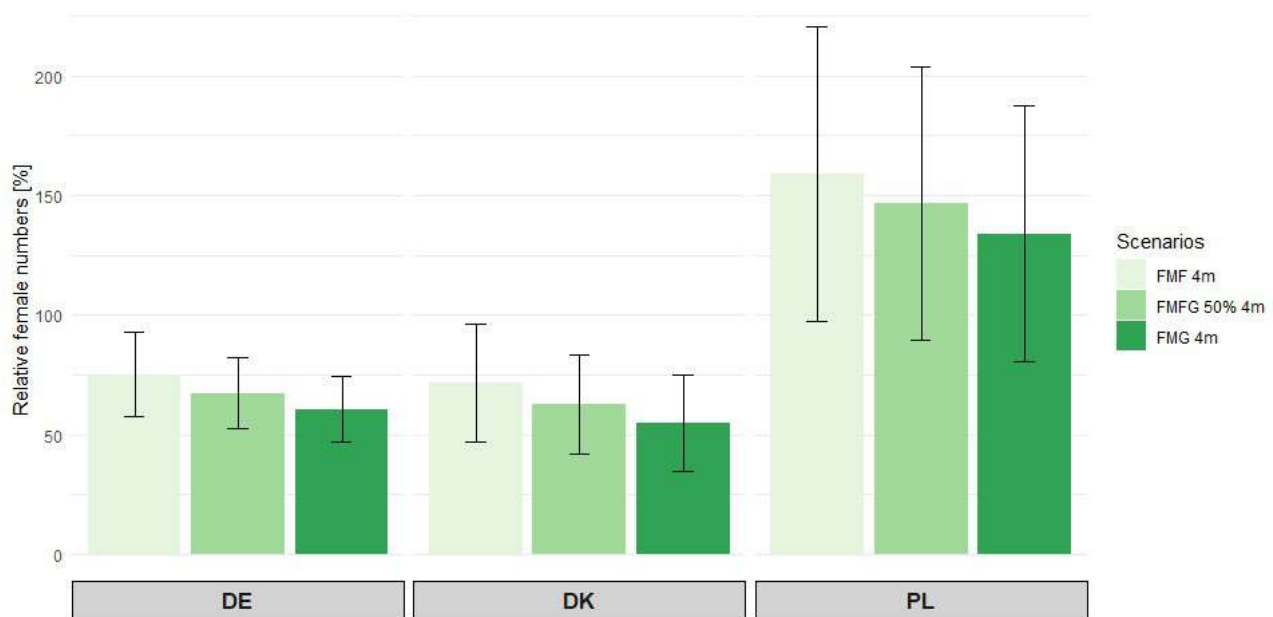


Figure 4.66 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

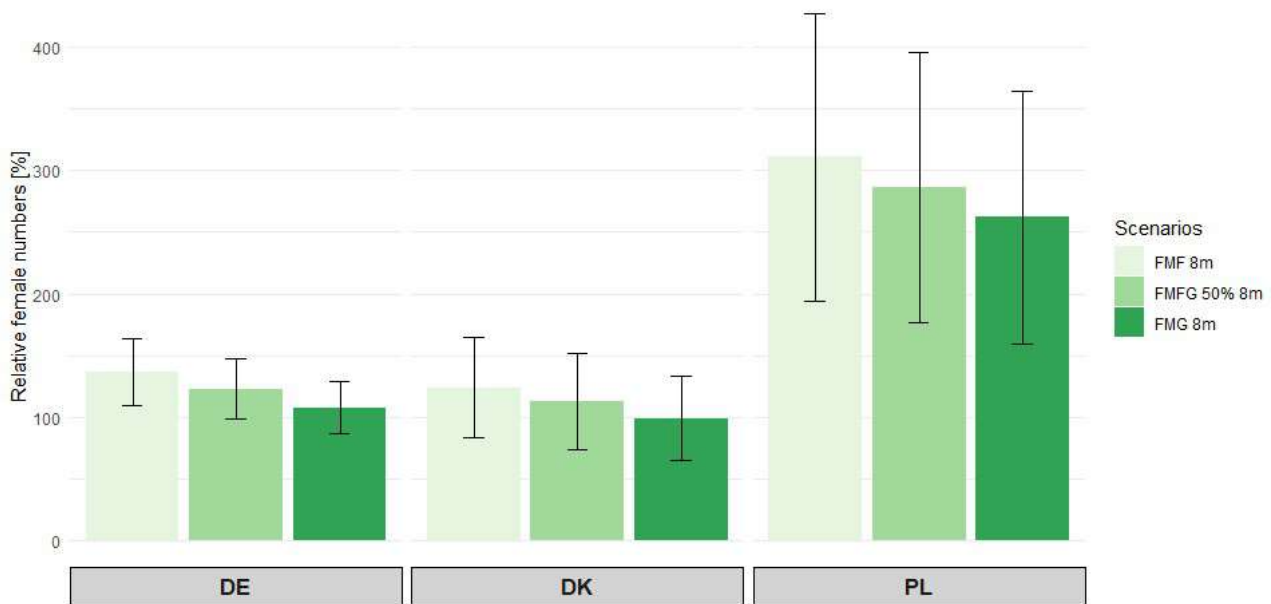


Figure 4.67 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.6 Setaside

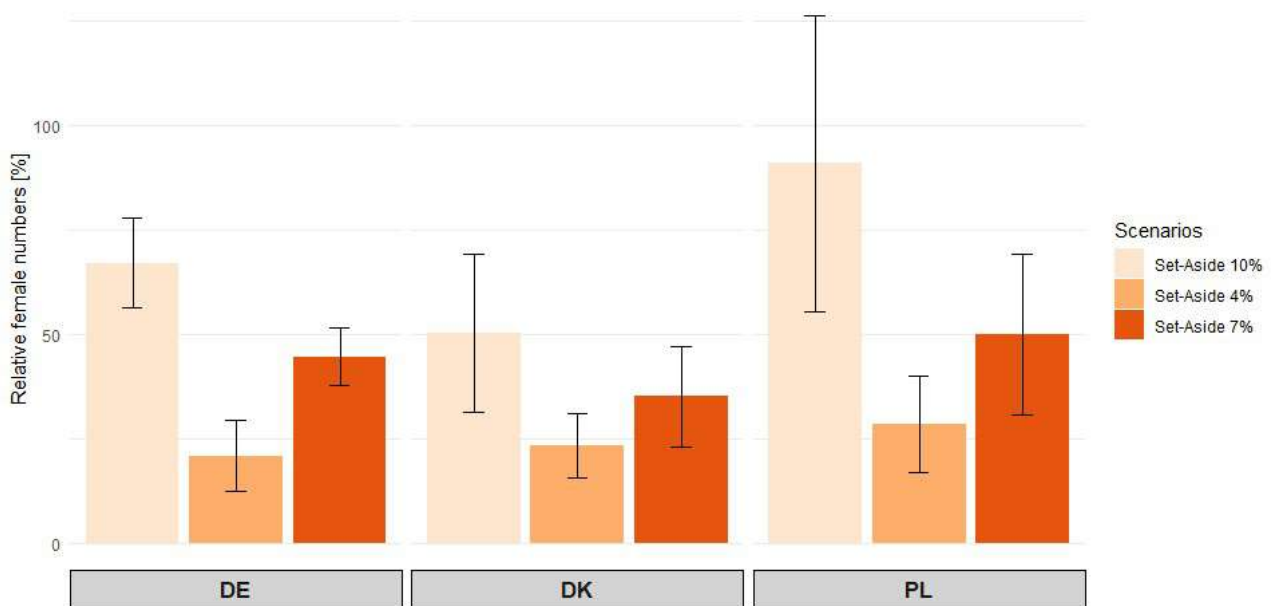


Figure 4.68 Setaside scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.7 Legume

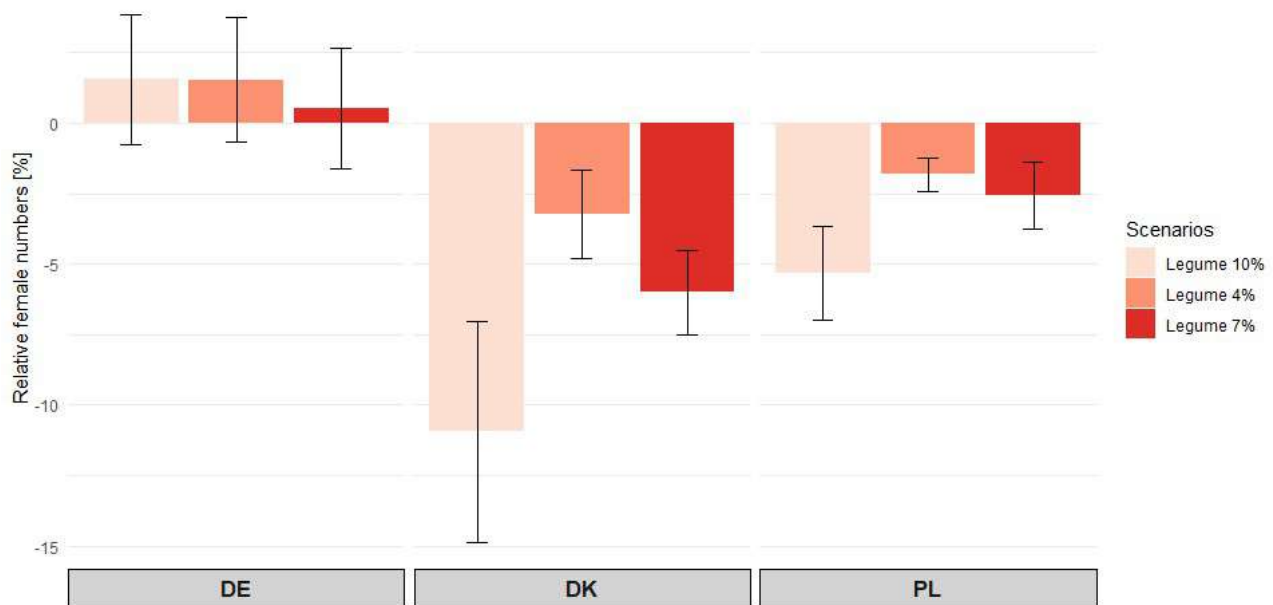


Figure 4.69 Legume scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.8 Biopesticides

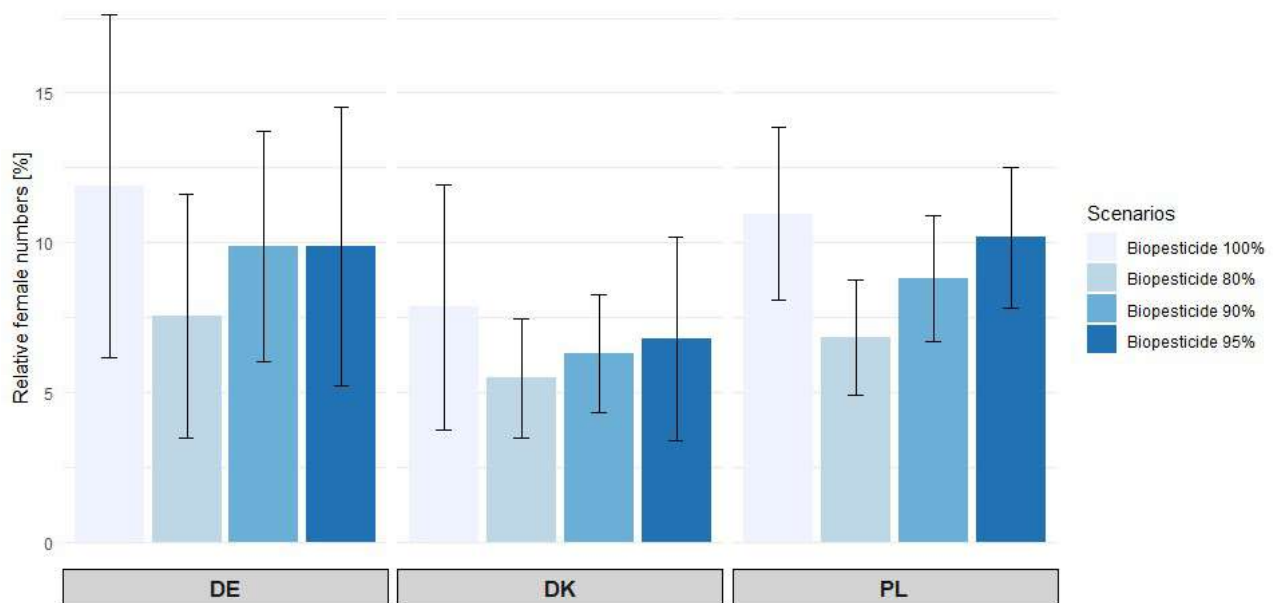


Figure 4.70 Biopesticide scenario with relative change in the number of female *Oedothorax* compared to baseline and standard deviation presented by error bars for each simulated country.

4.5.9 Table: Country level overview of scenario effects

Table 4.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for *Oedothorax*. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	PL
Diversification	-2% (SD 7%)	-0% (SD 6%)	NA
FMF 2m	45% (SD 10%)	44% (SD 14%)	89% (SD 35%)
FMF 4m	75% (SD 18%)	72% (SD 25%)	159% (SD 62%)
FMF 8m	137% (SD 27%)	124% (SD 40%)	311% (SD 117%)
FMG 2m	36% (SD 8%)	34% (SD 12%)	75% (SD 30%)
FMG 4m	61% (SD 14%)	55% (SD 20%)	134% (SD 53%)
FMG 8m	108% (SD 21%)	99% (SD 34%)	262% (SD 102%)
FMFG 50% 2m	42% (SD 9%)	38% (SD 13%)	82% (SD 32%)
FMFG 50% 4m	67% (SD 15%)	63% (SD 21%)	147% (SD 57%)
FMFG 50% 8m	123% (SD 25%)	113% (SD 39%)	287% (SD 109%)
Set-Aside 4%	21% (SD 8%)	23% (SD 8%)	29% (SD 12%)
Set-Aside 7%	45% (SD 7%)	35% (SD 12%)	50% (SD 19%)
Set-Aside 10%	67% (SD 11%)	50% (SD 19%)	91% (SD 35%)
Legume 4%	2% (SD 2%)	-3% (SD 2%)	-2% (SD 1%)
Legume 7%	1% (SD 2%)	-6% (SD 1%)	-3% (SD 1%)
Legume 10%	2% (SD 2%)	-11% (SD 4%)	-5% (SD 2%)
Biopesticide 80%	8% (SD 4%)	5% (SD 2%)	7% (SD 2%)
Biopesticide 90%	10% (SD 4%)	6% (SD 2%)	9% (SD 2%)
Biopesticide 95%	10% (SD 5%)	7% (SD 3%)	10% (SD 2%)
Biopesticide 100%	12% (SD 6%)	8% (SD 4%)	11% (SD 3%)

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5 ERIGONE

5.1 Baselines

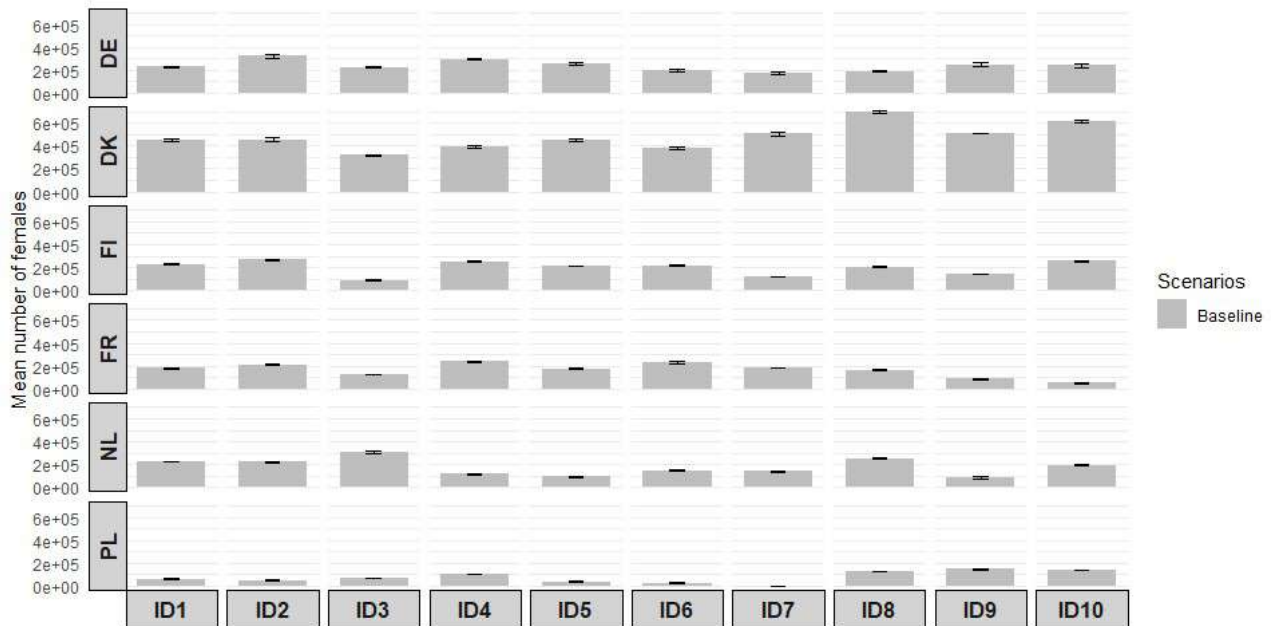


Figure 5.1 Erigone baselines for each country and landscape.

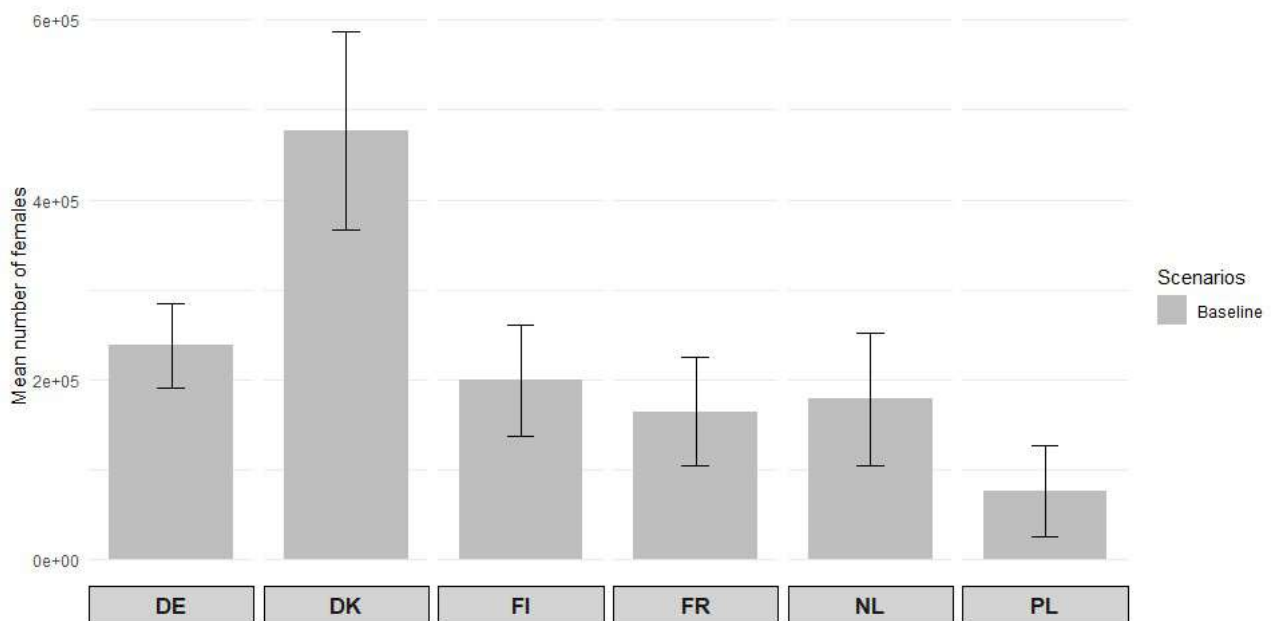


Figure 5.2 Erigone baselines for each country combined across landscapes.

5.2 Germany

5.2.1 Crop diversification

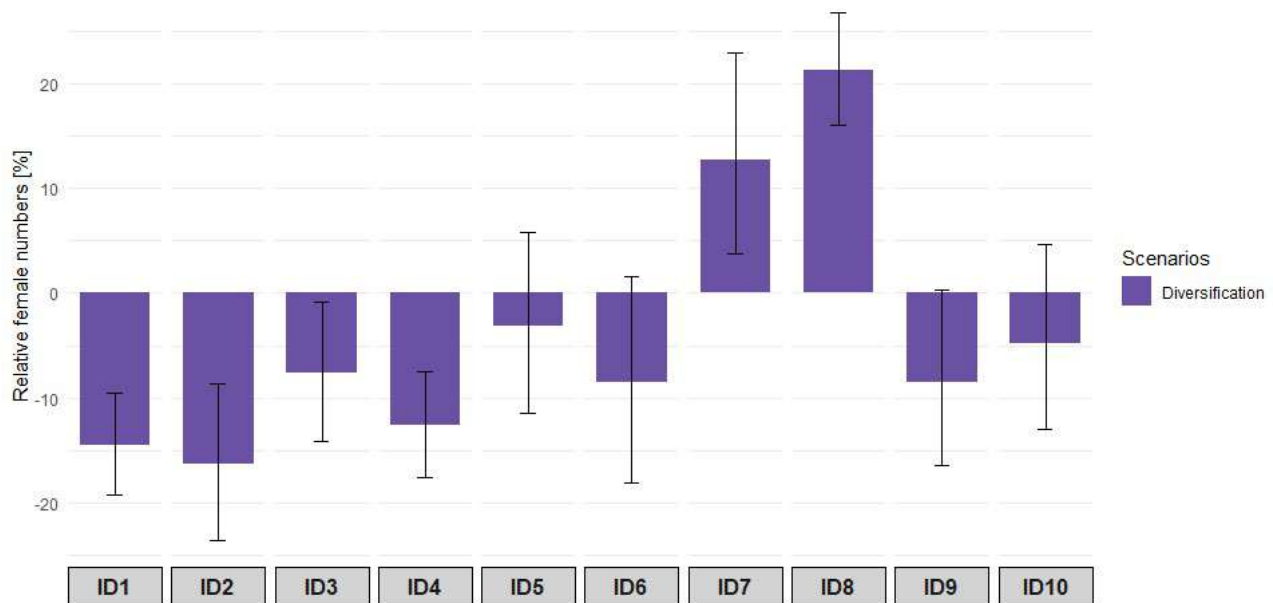


Figure 5.3 Diversification scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

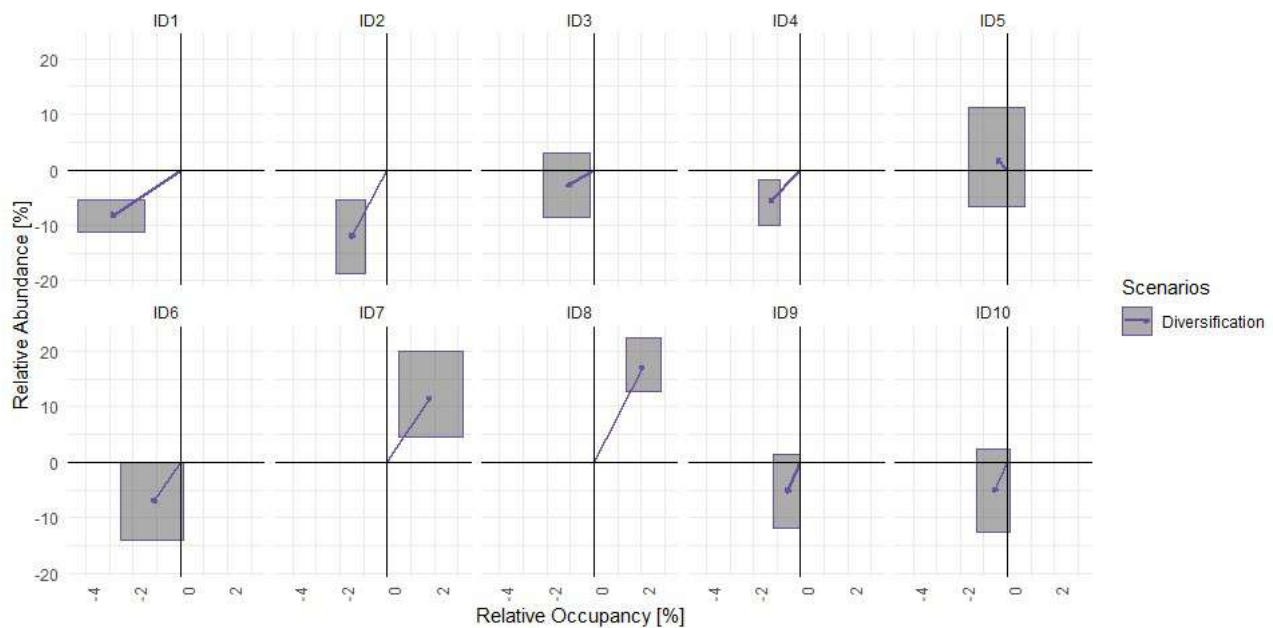


Figure 5.4 Diversification scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.2 Flower field margins

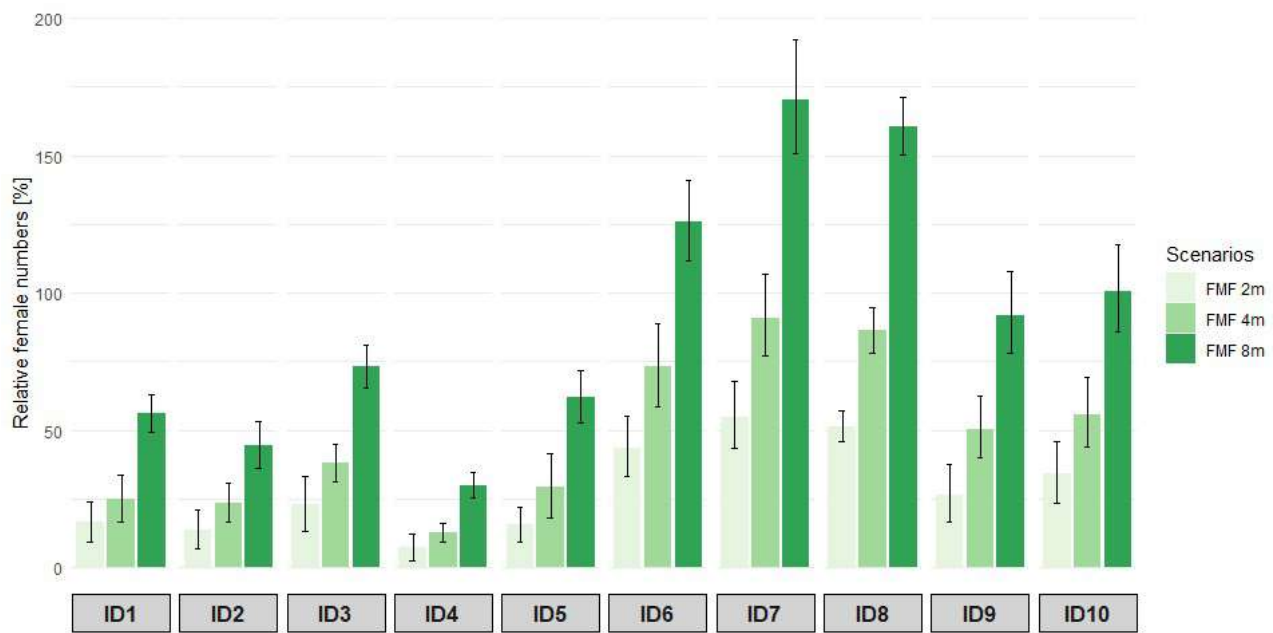


Figure 5.5 Flower field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

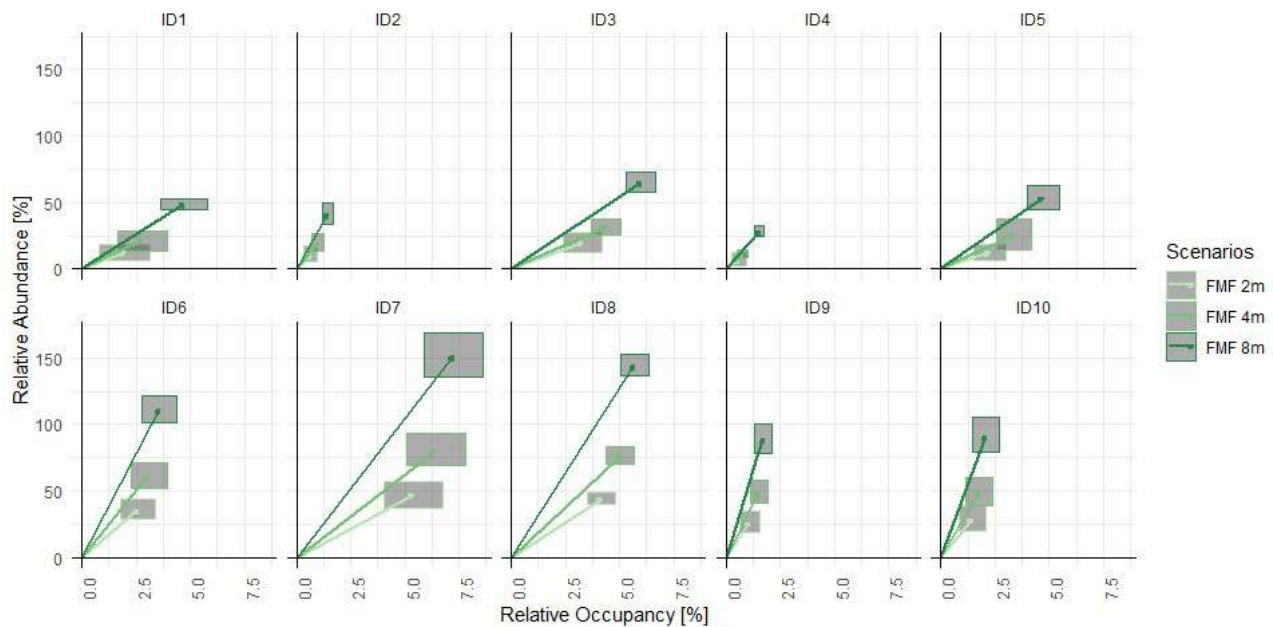


Figure 5.6 Flower field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.3 Grassy field margins

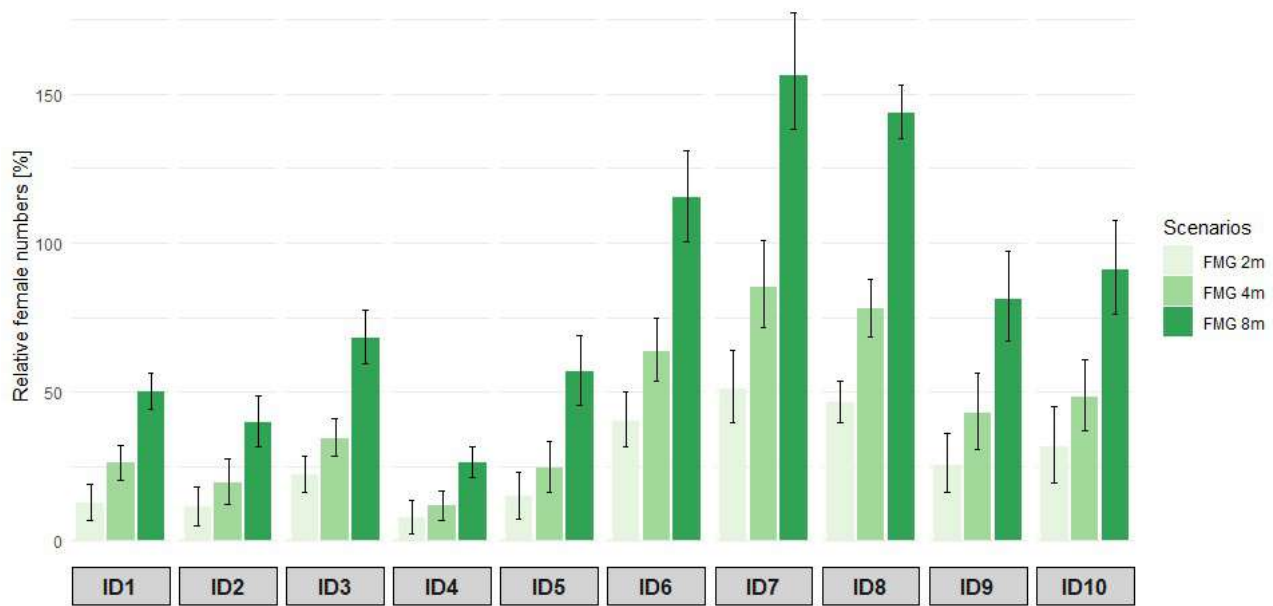


Figure 5.7 Grassy field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

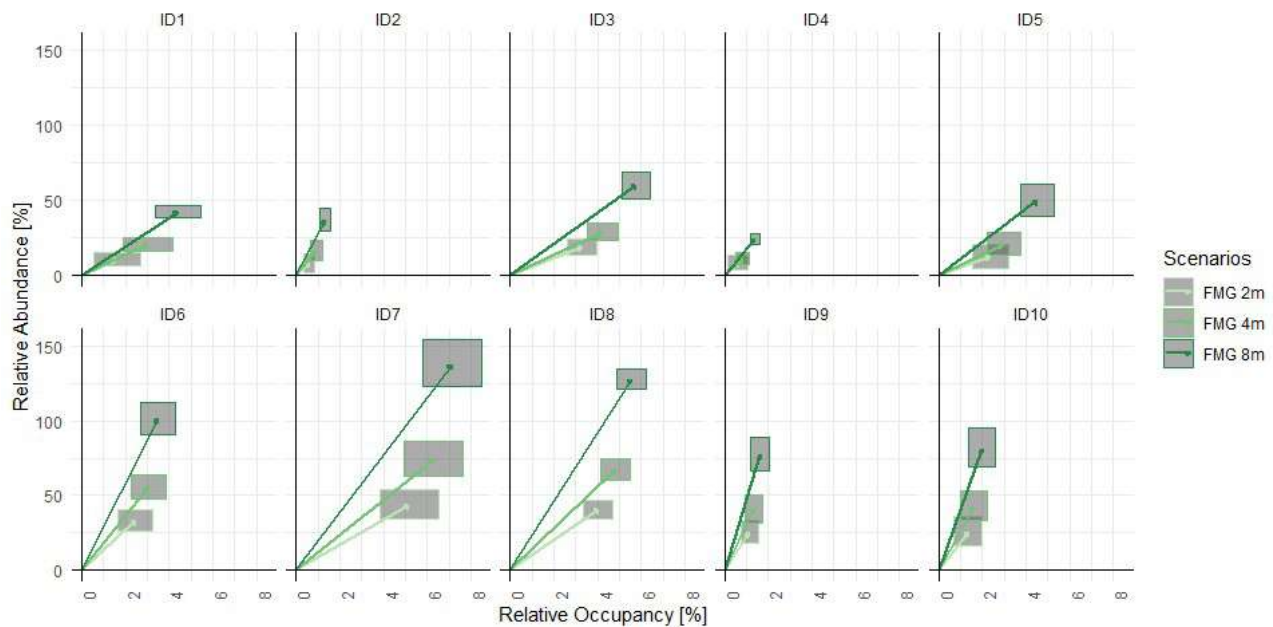


Figure 5.8 Grassy field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.4 Mixed field margins

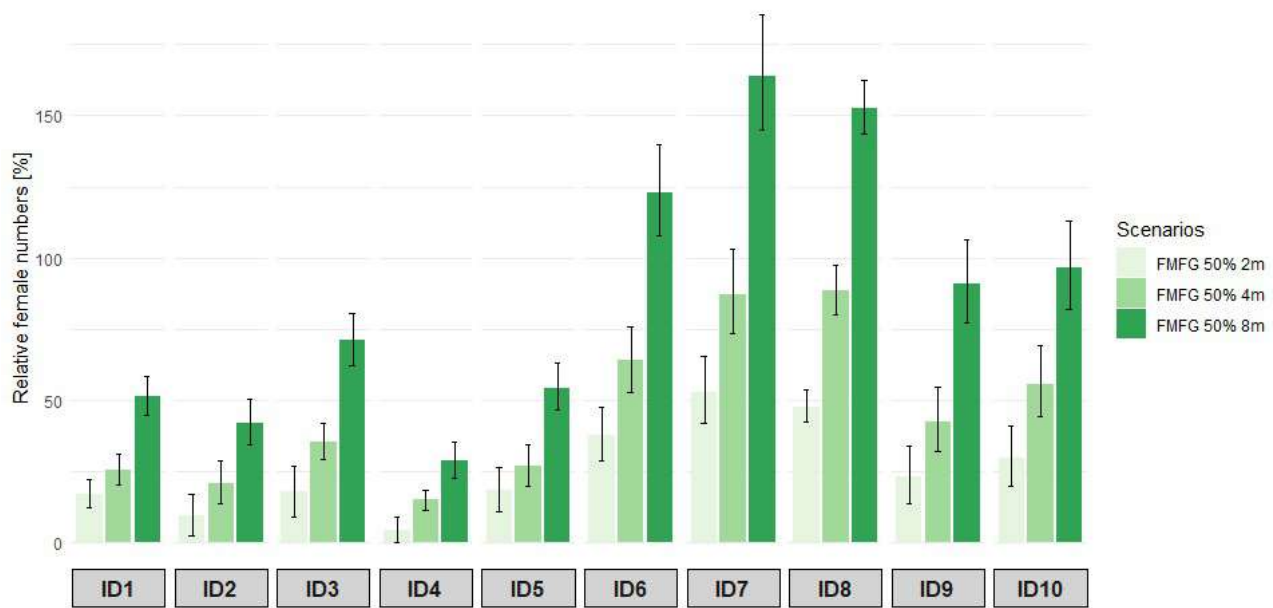


Figure 5.9 Mixed field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

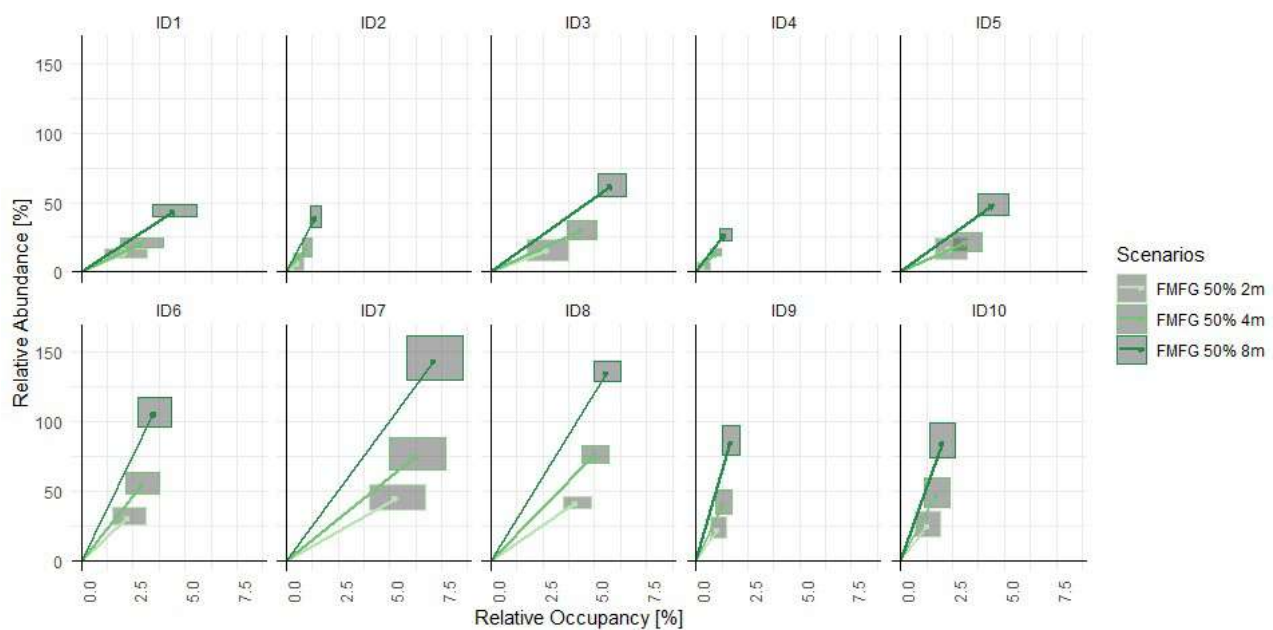


Figure 5.10 Mixed field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.5 Flower, grassy and mixed field margins

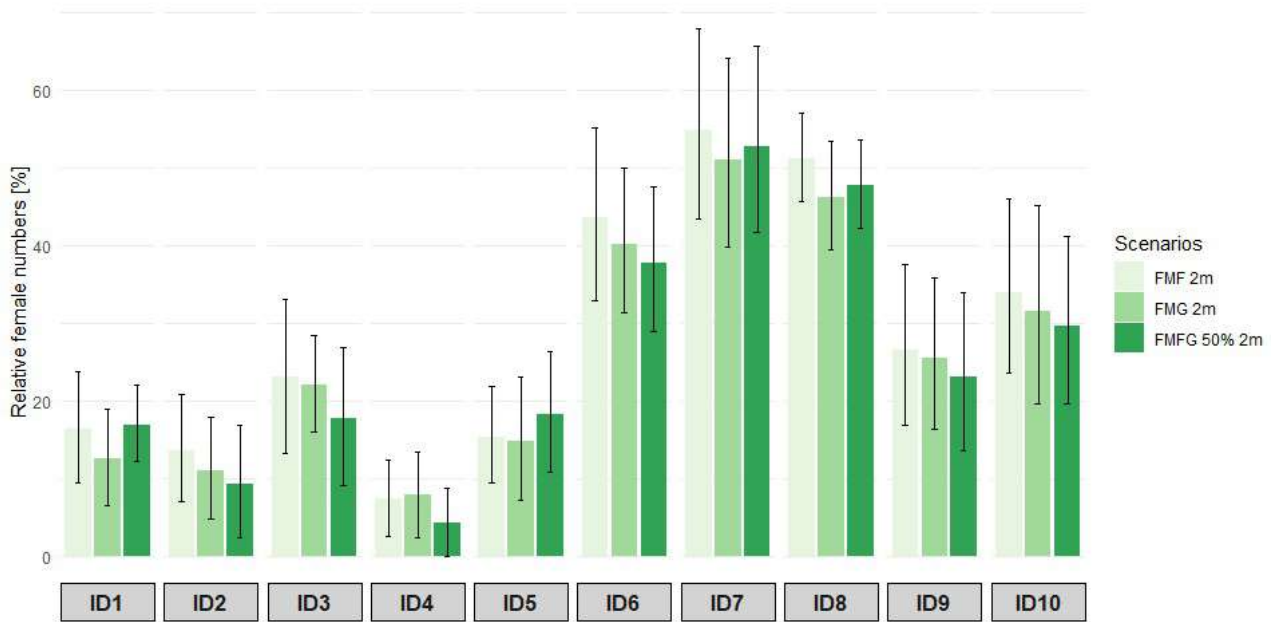


Figure 5.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

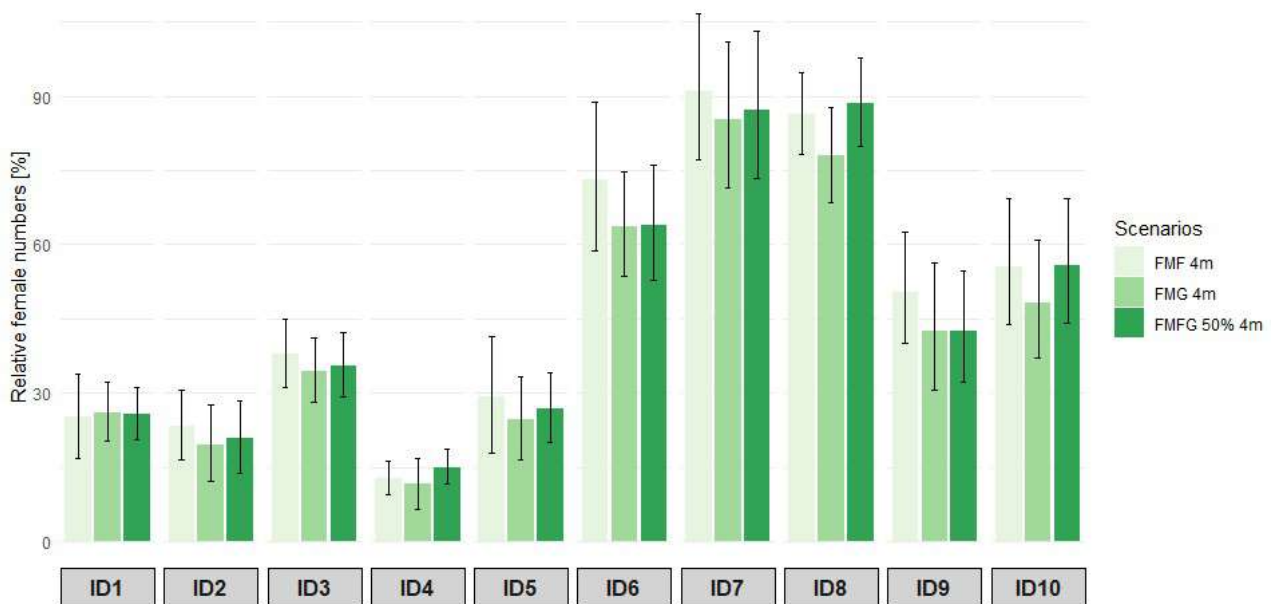


Figure 5.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

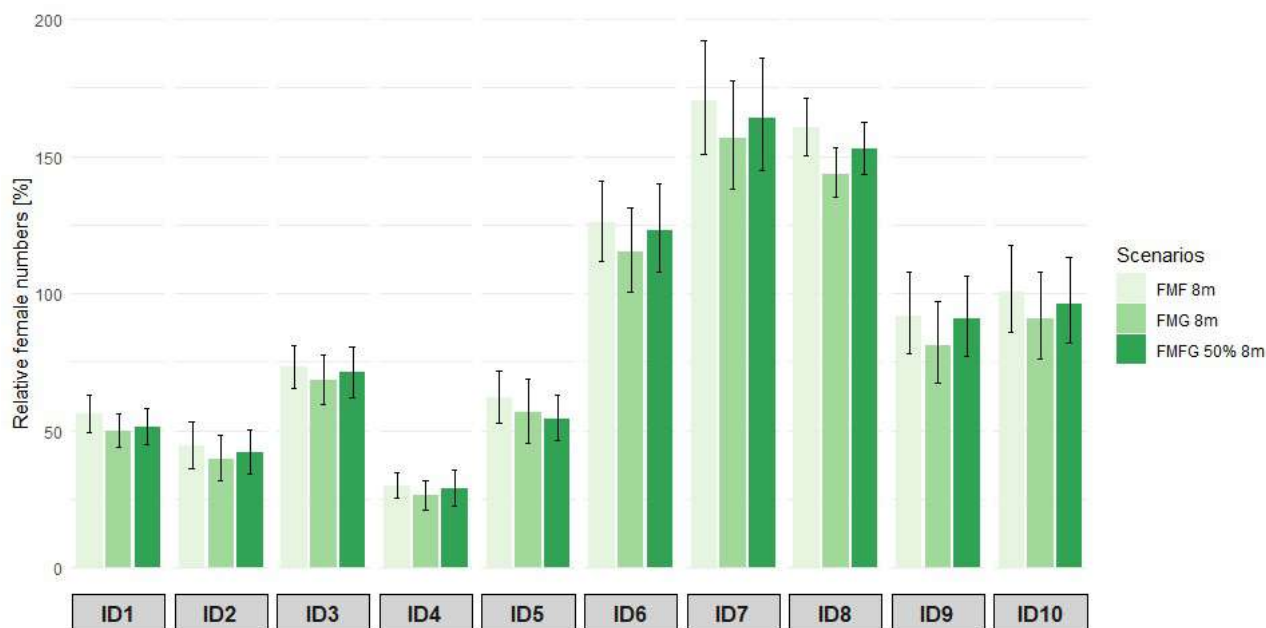


Figure 5.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

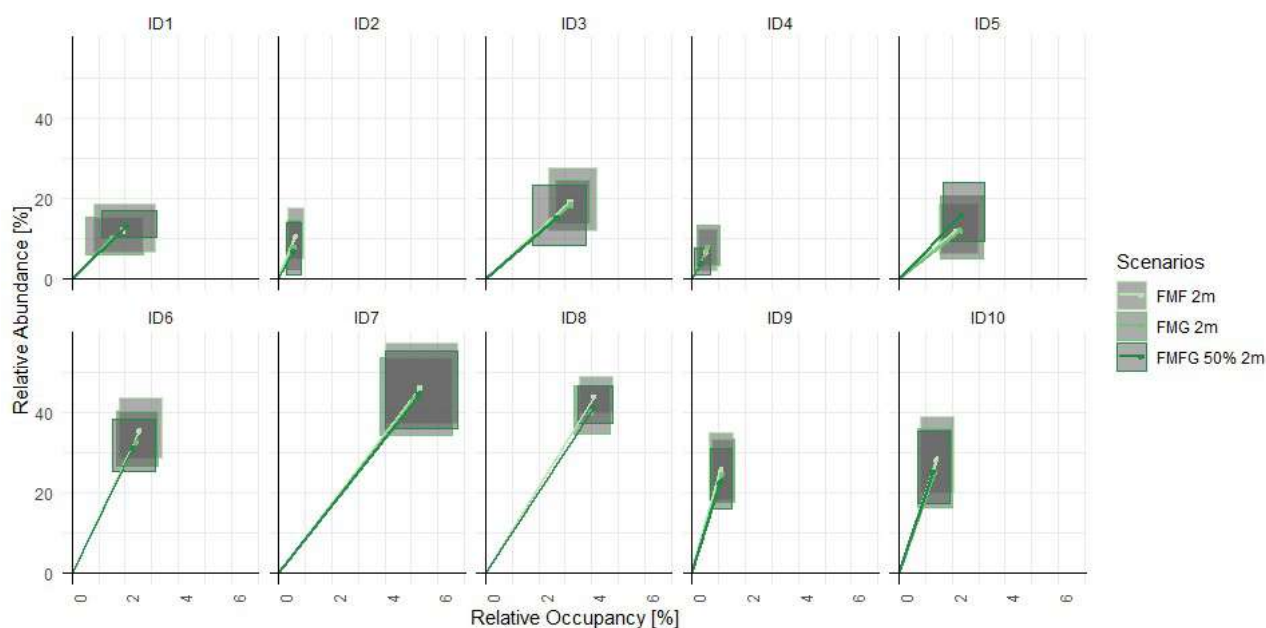


Figure 5.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

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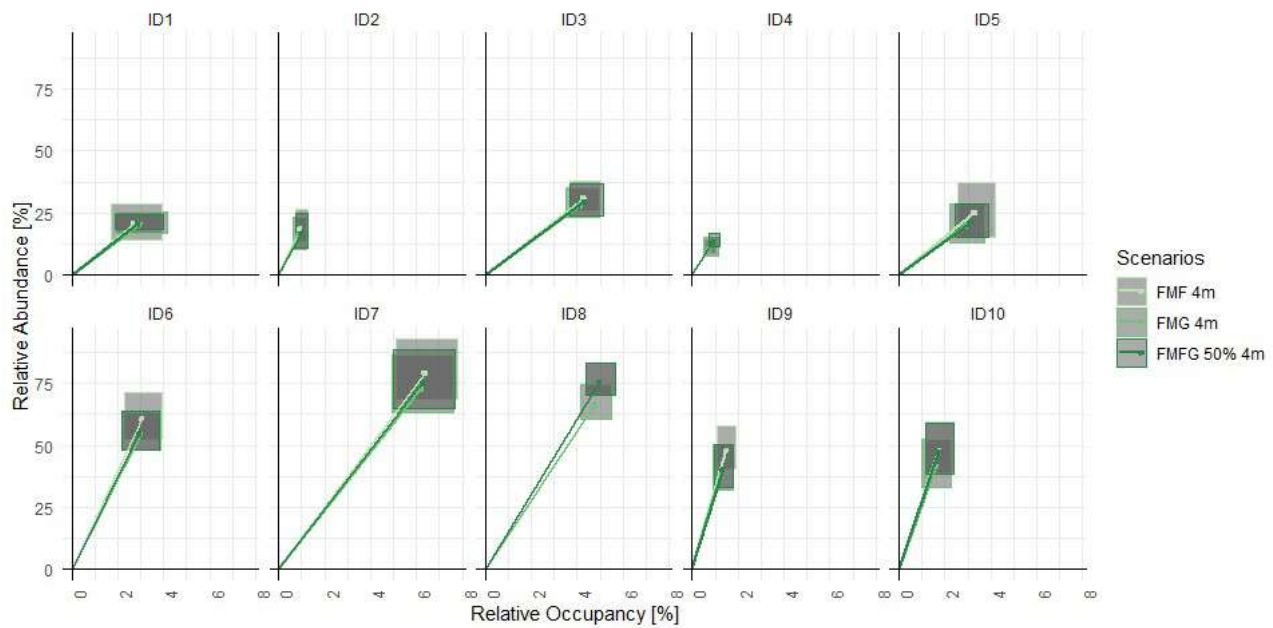


Figure 5.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes..

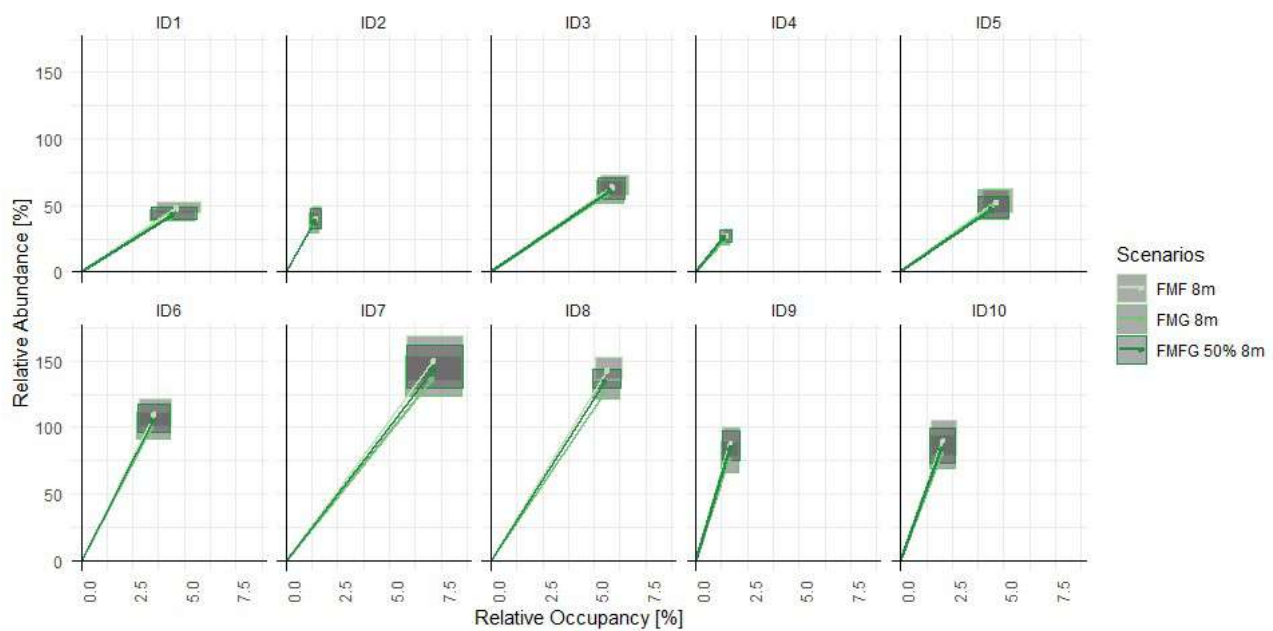


Figure 5.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.6 Setaside

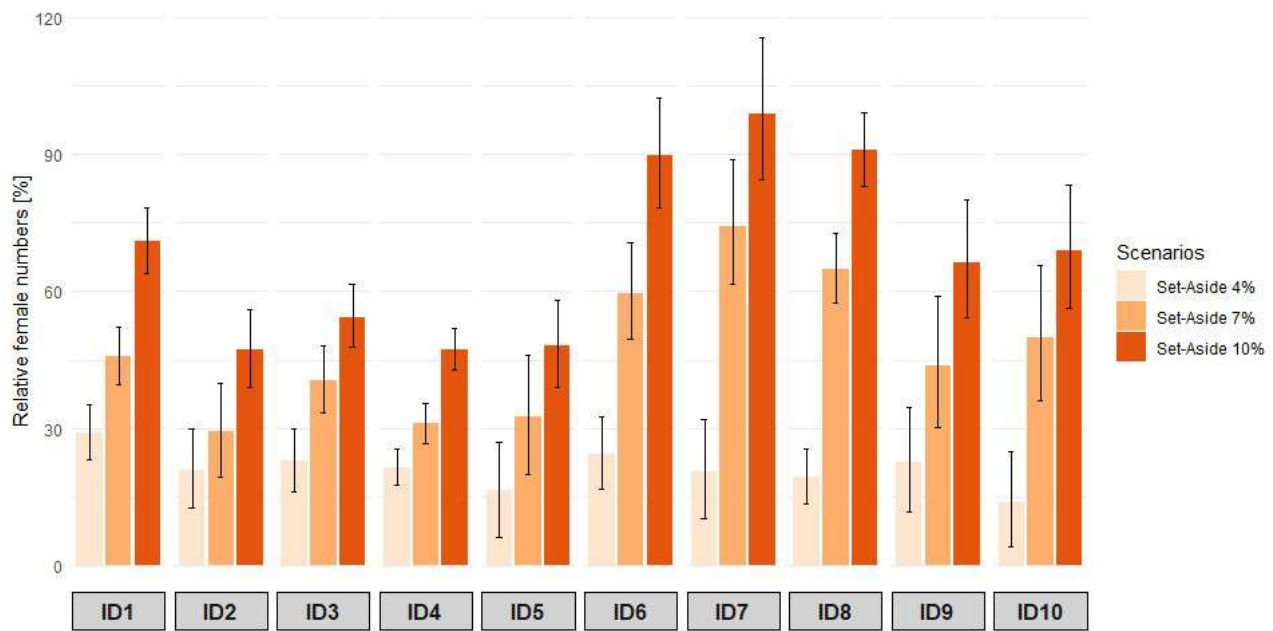


Figure 5.17 Setaside scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

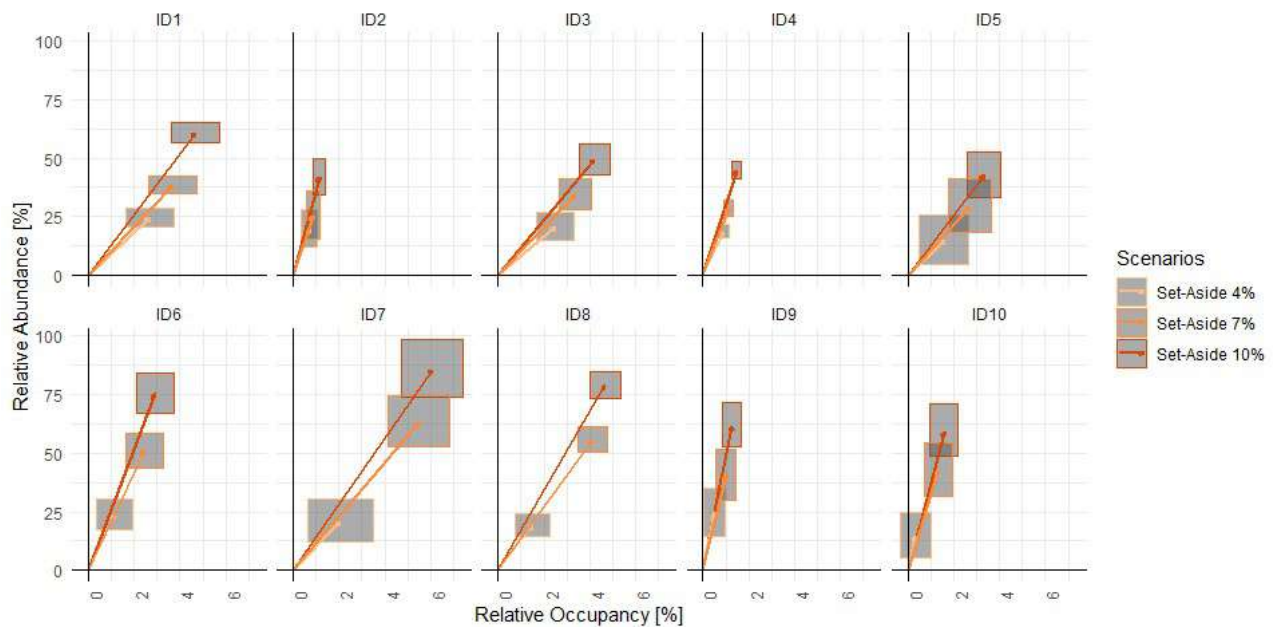


Figure 5.18 Setaside scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.7 Legume

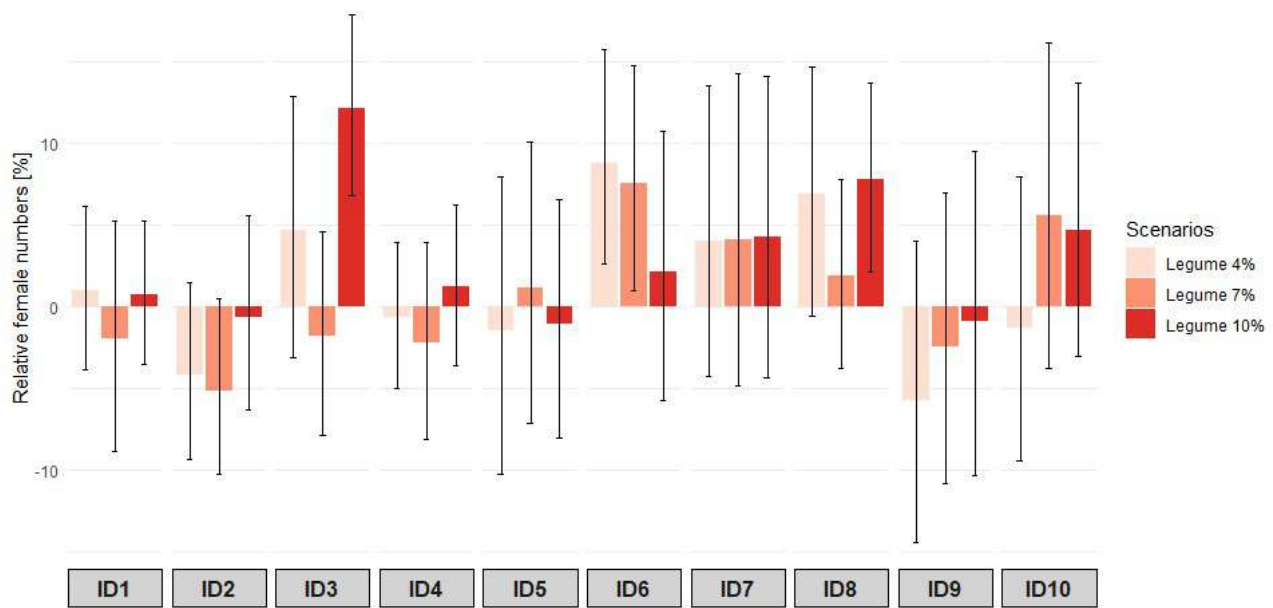


Figure 5.19 Legume scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

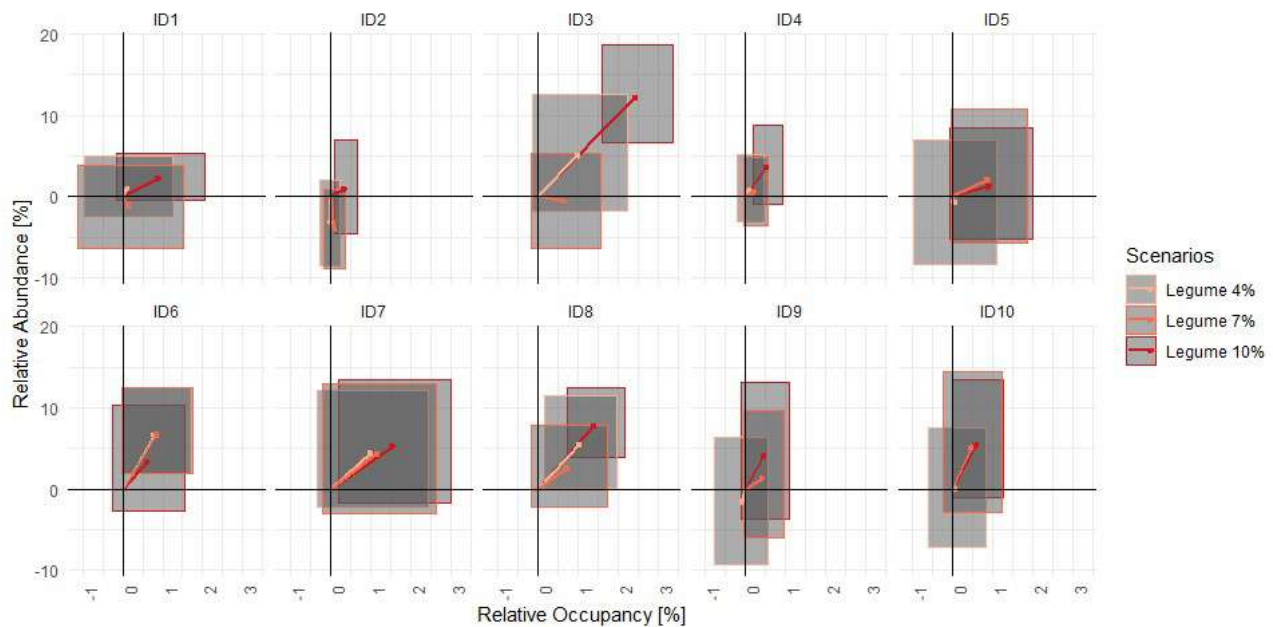


Figure 5.20 Legume scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.2.8 Biopesticides

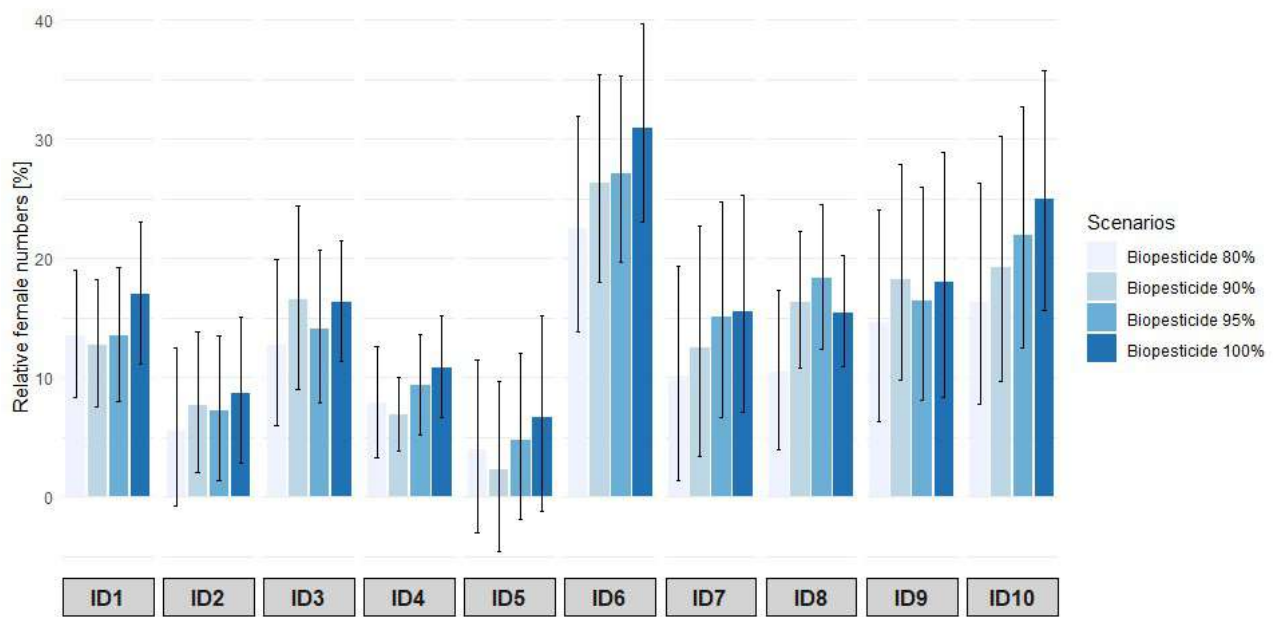


Figure 5.21 Biopesticide scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Germany.

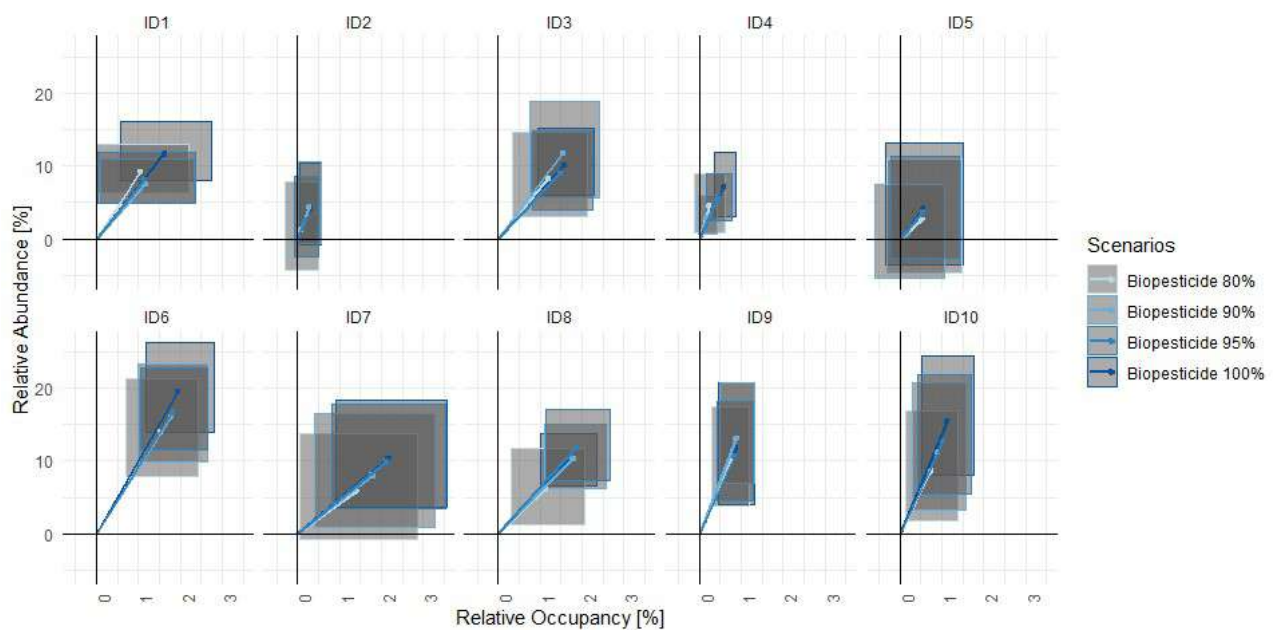


Figure 5.22 Biopesticide scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3 Denmark

5.3.1 Crop diversification

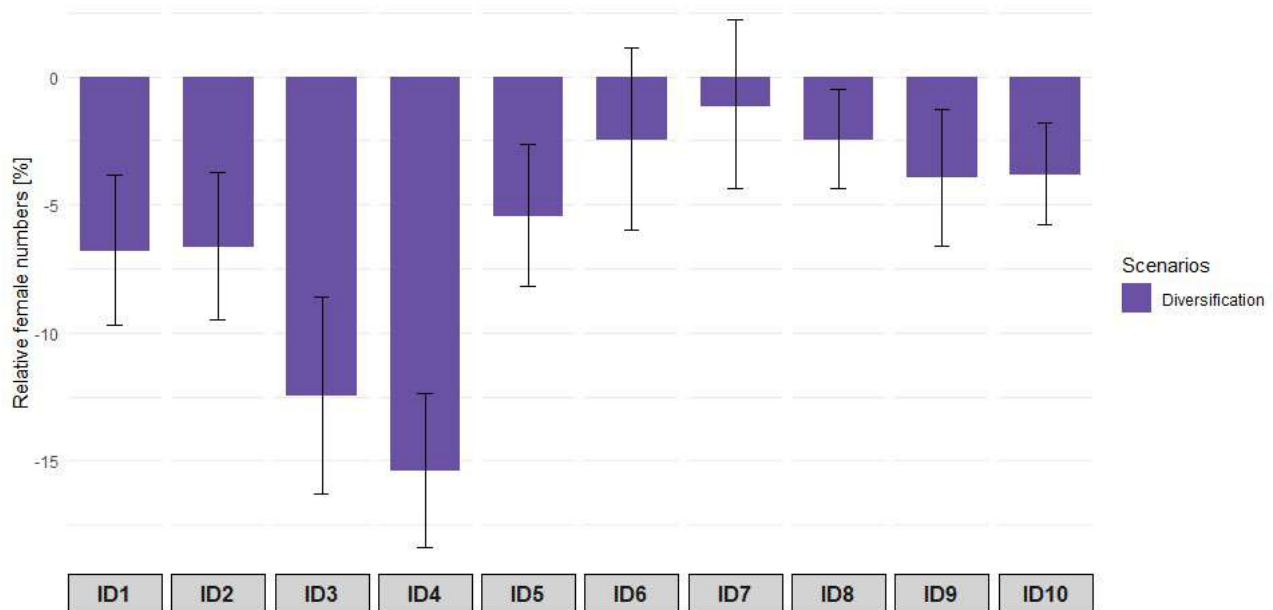


Figure 5.23 Diversification scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

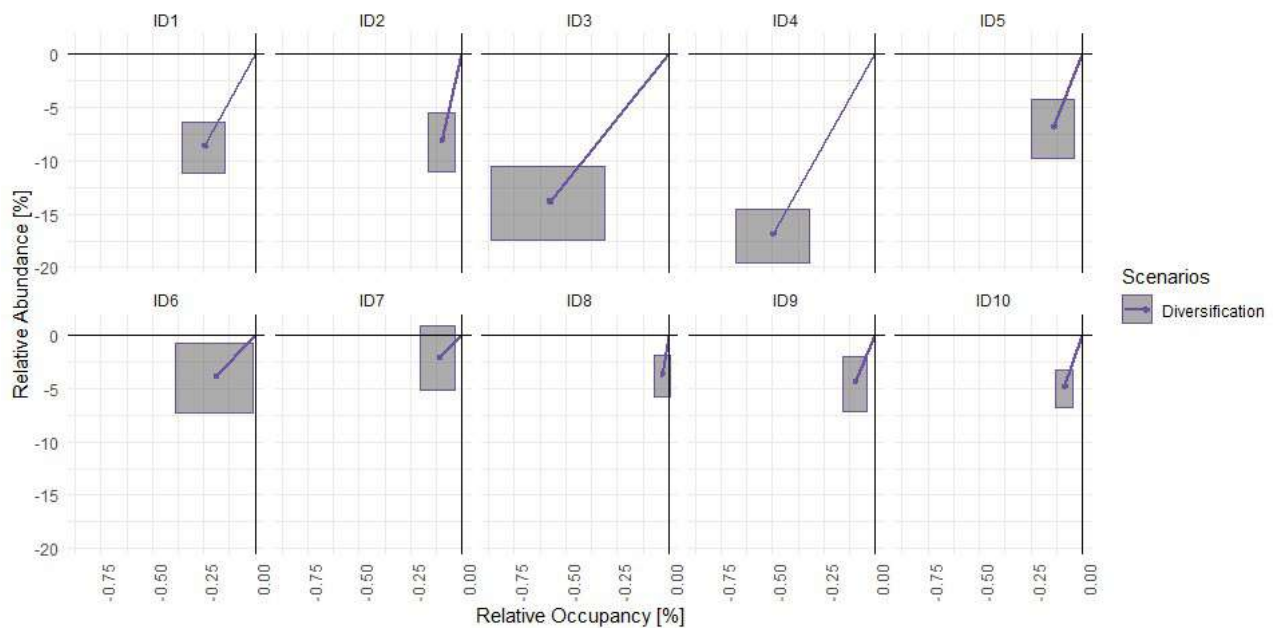


Figure 5.24 Diversification scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.2 Flower field margins

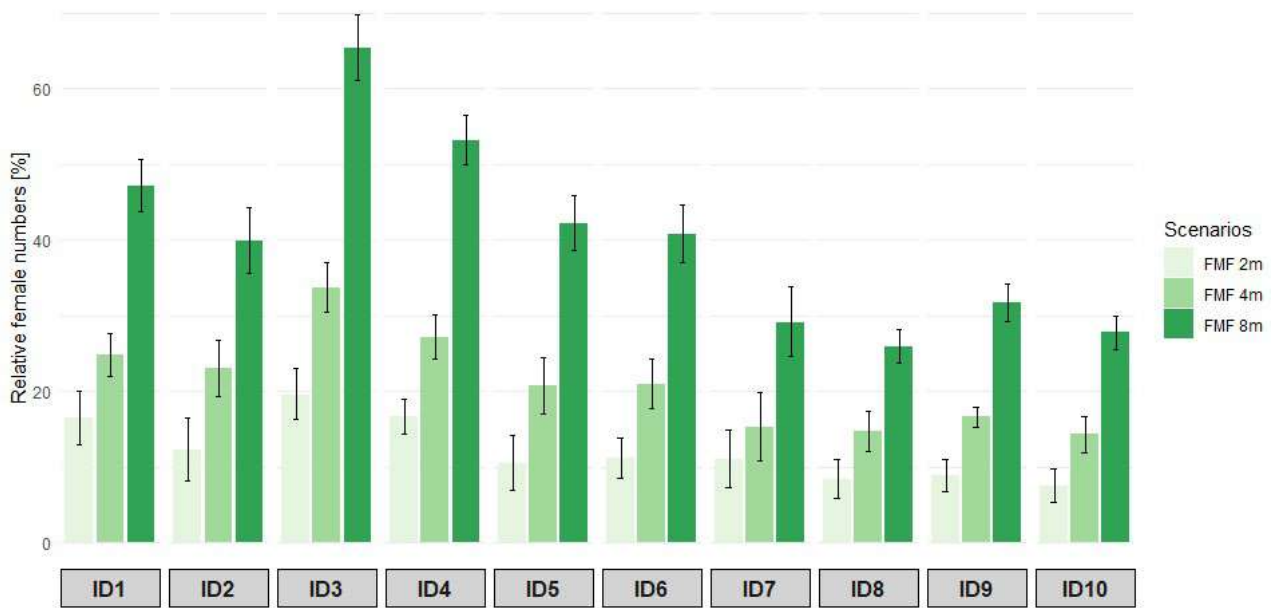


Figure 5.25 Flower field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

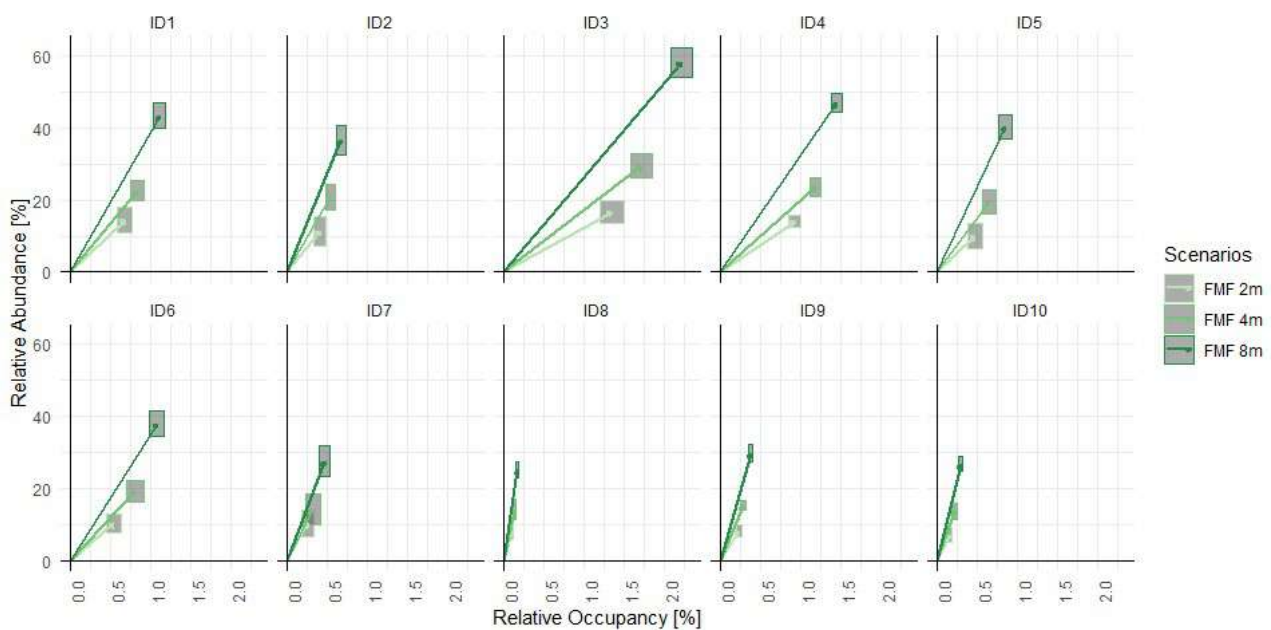


Figure 5.26 Flower field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.3 Grassy field margins

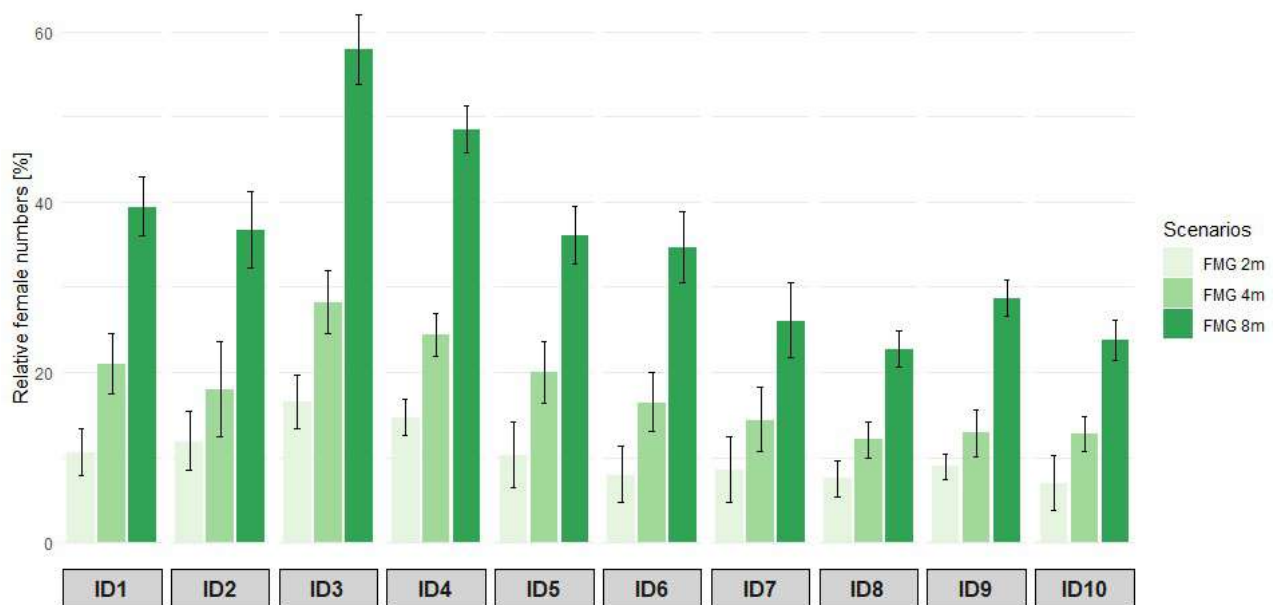


Figure 5.27 Grassy field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

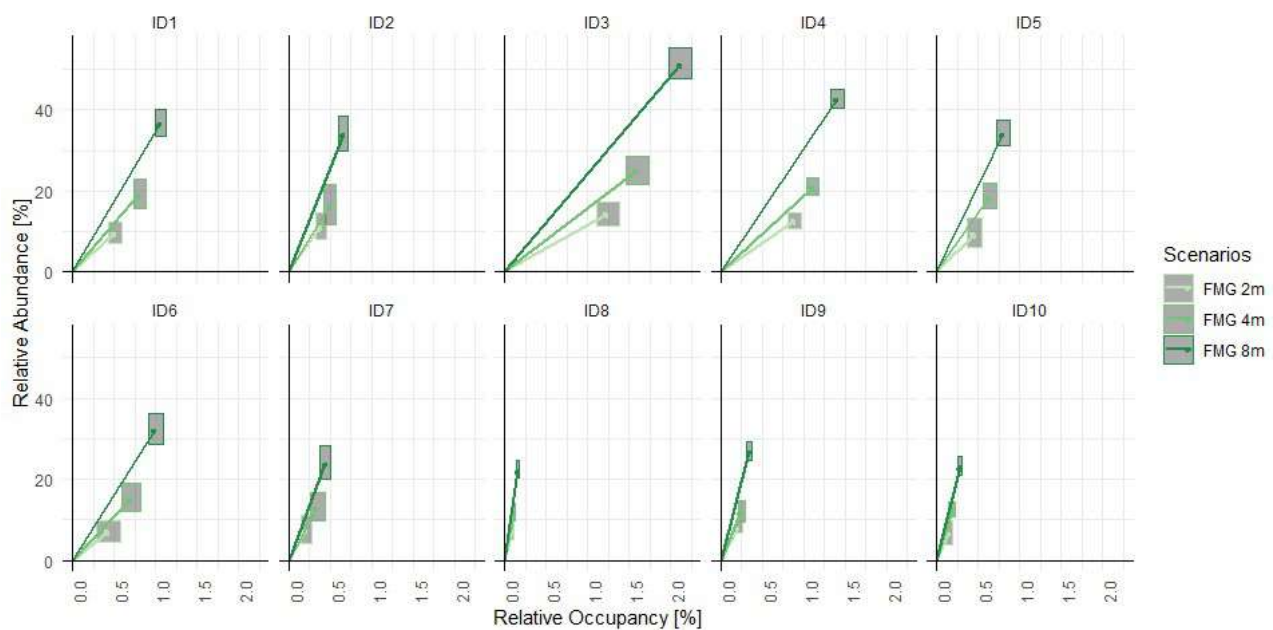


Figure 5.28 Grassy field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.4 Mixed field margins

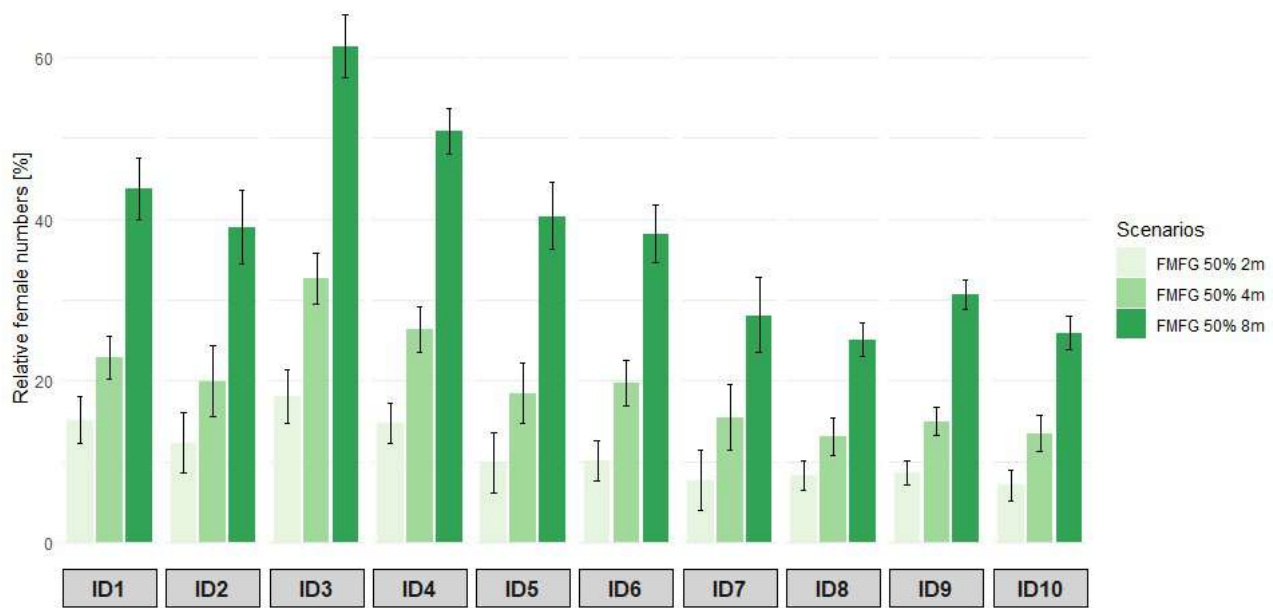


Figure 5.29 Mixed field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

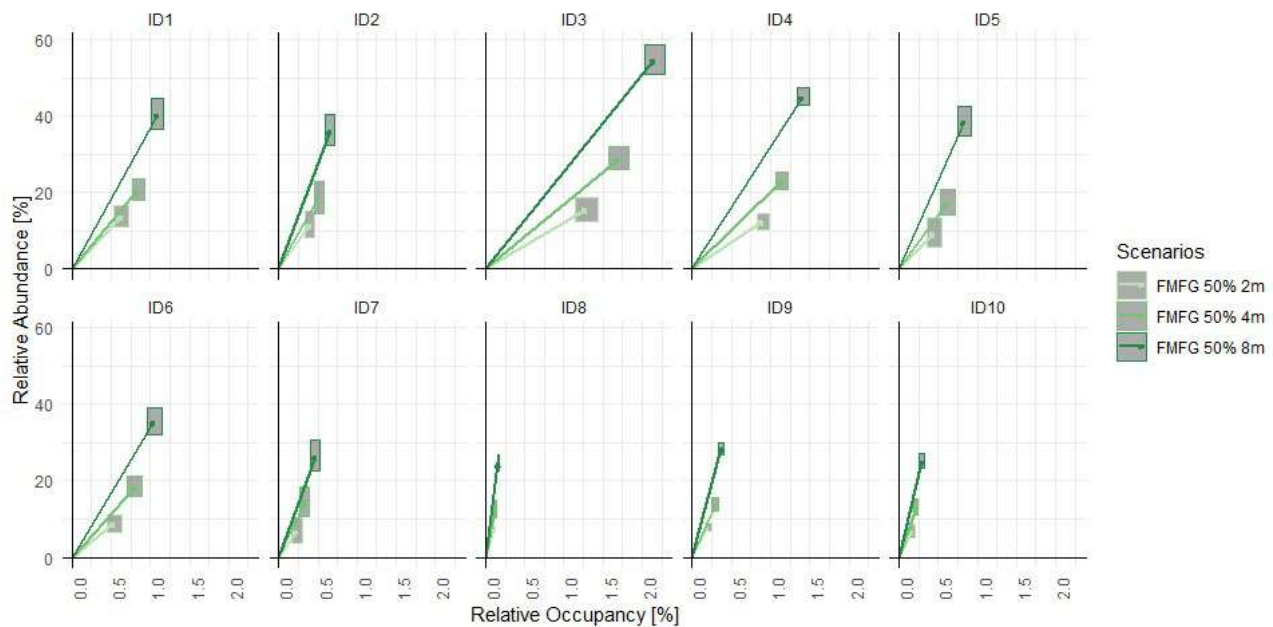


Figure 5.30 Mixed field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.5 Flower, grassy and mixed field margins

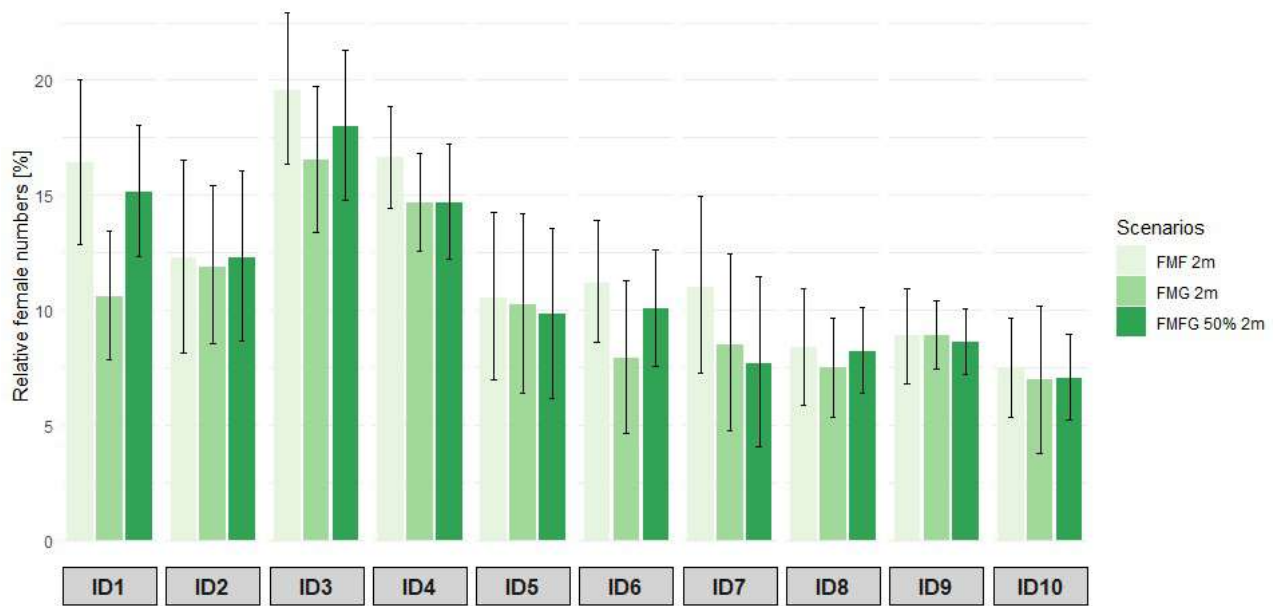


Figure 5.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

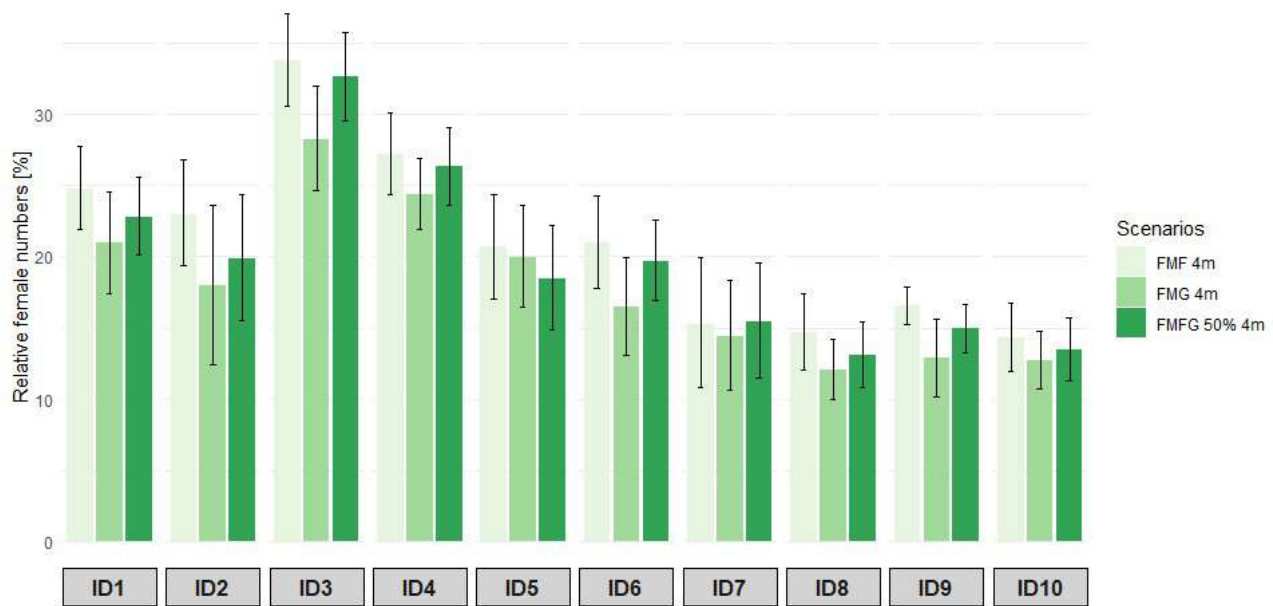


Figure 5.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.



Figure 5.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

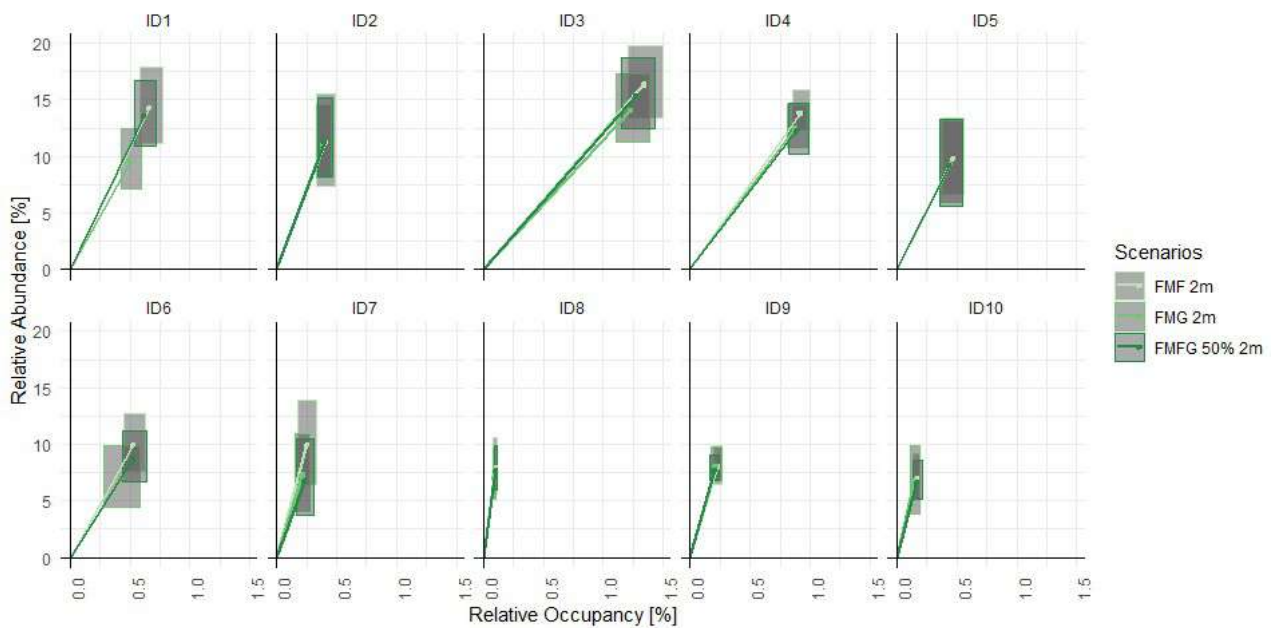


Figure 5.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

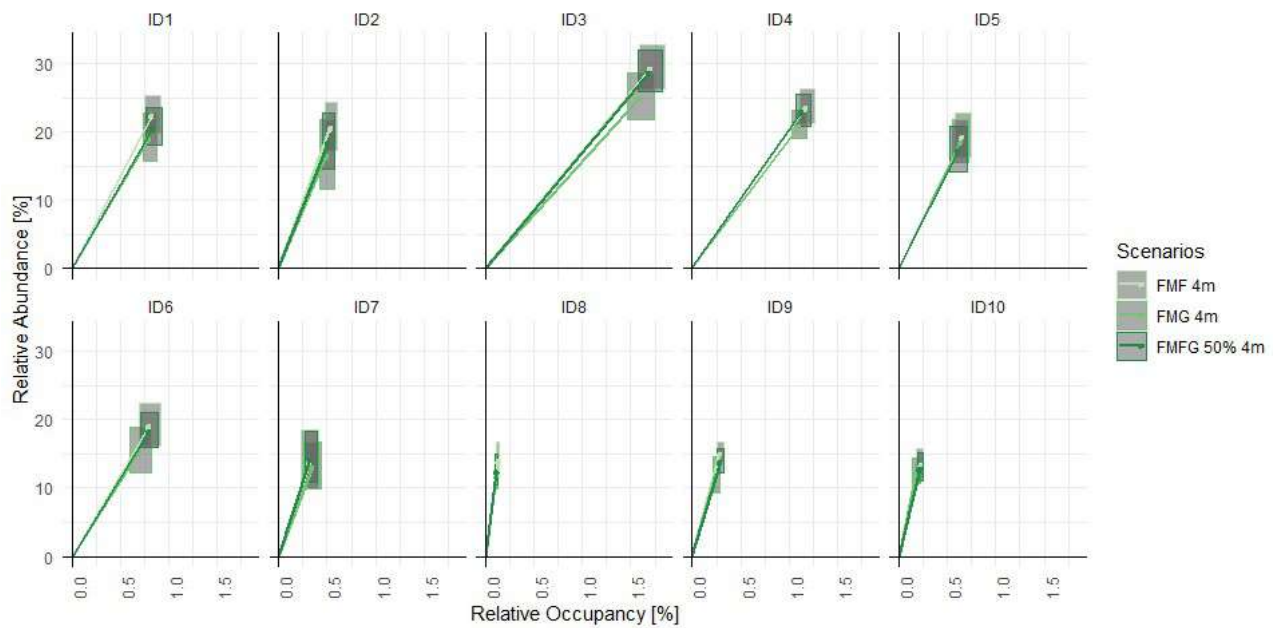


Figure 5.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes..

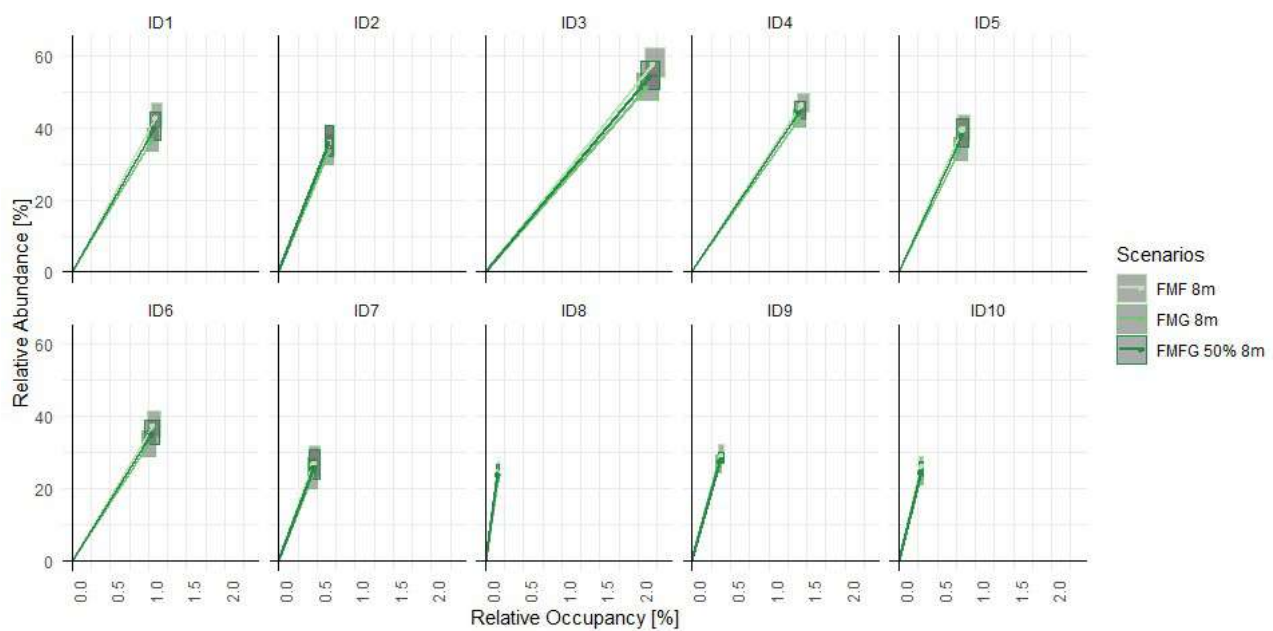


Figure 5.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.6 Setaside

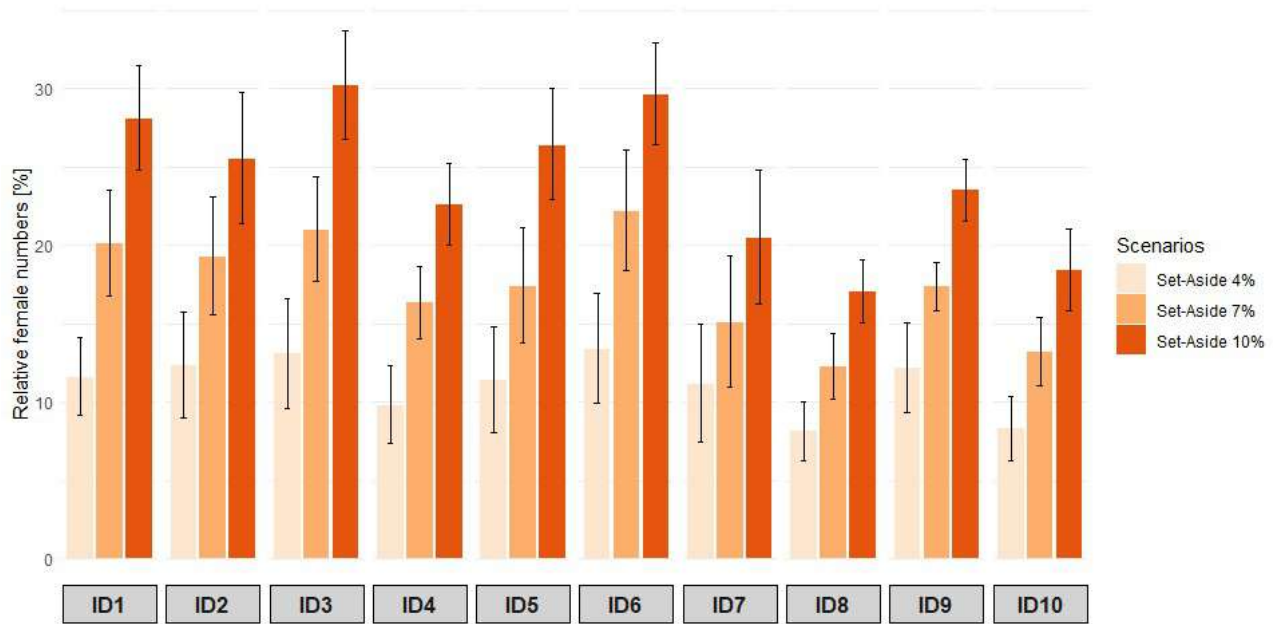


Figure 5.37 Setaside scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

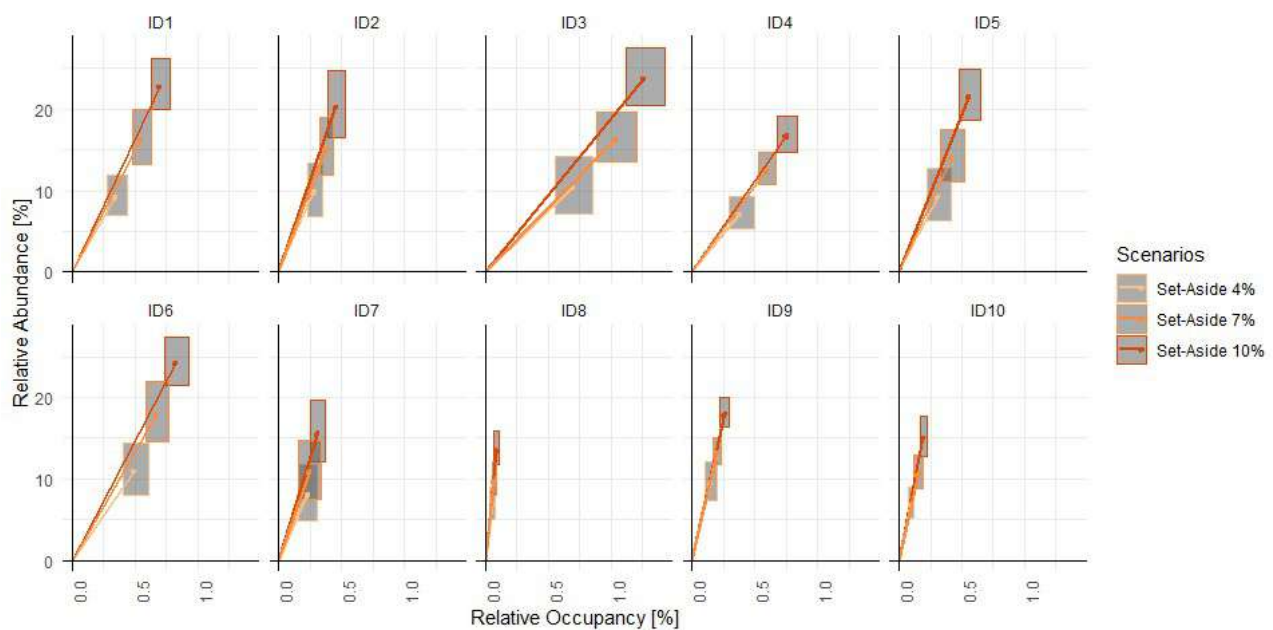


Figure 5.38 Setaside scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.7 Legume

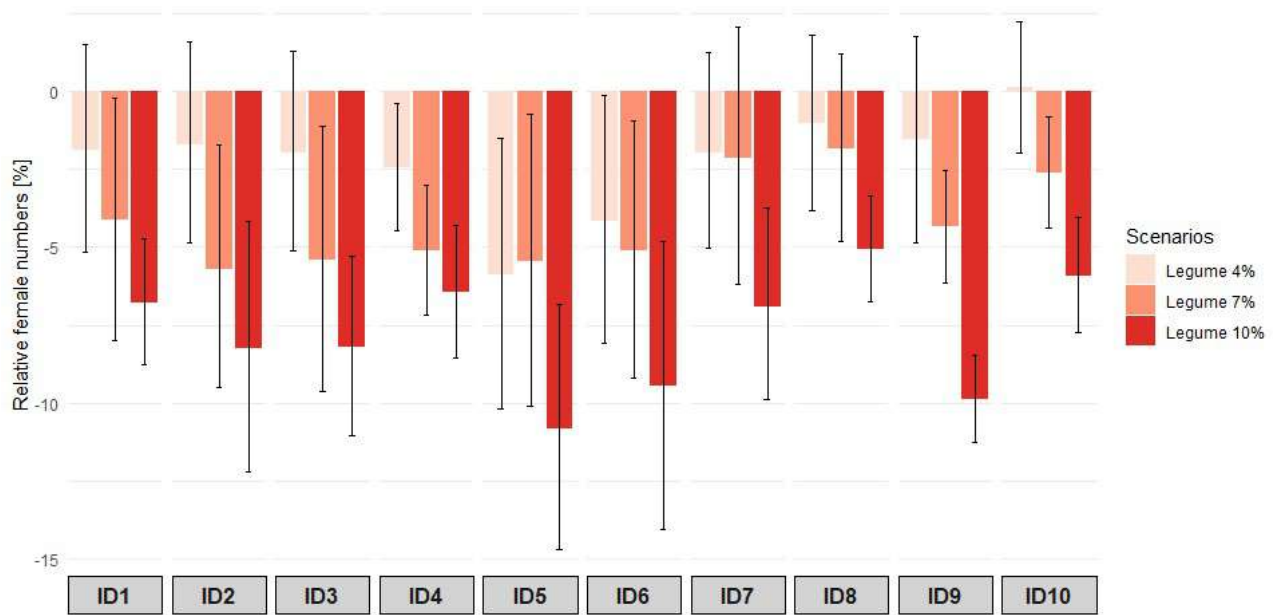


Figure 5.39 Legume scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

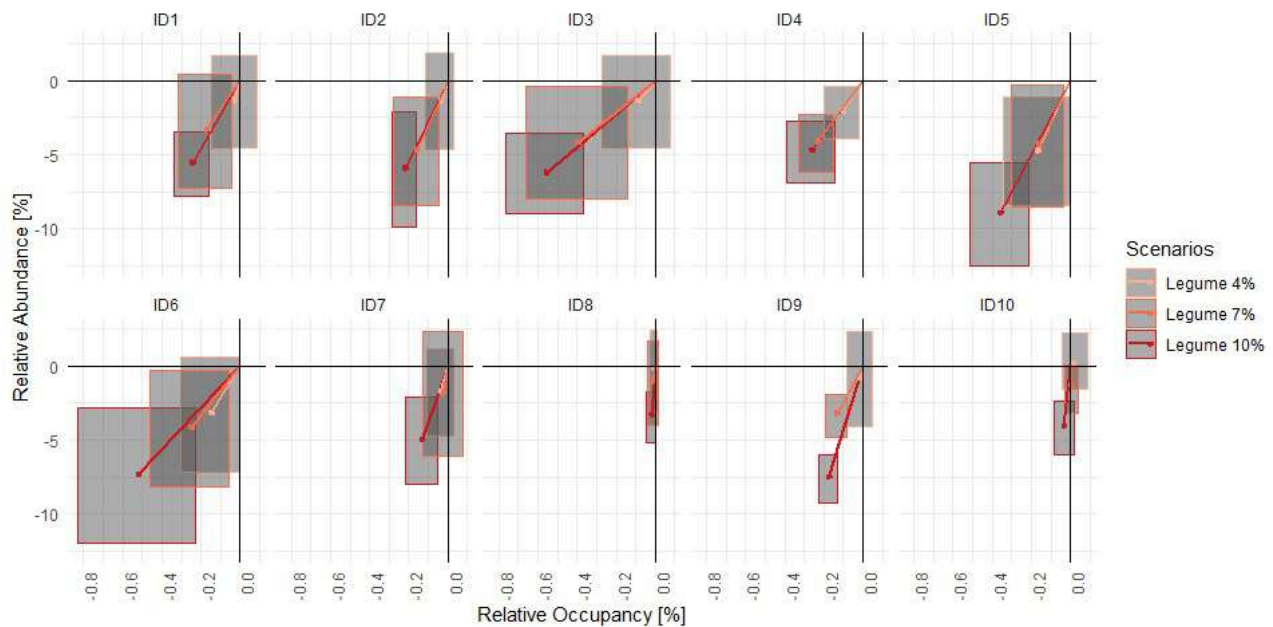


Figure 5.40 Legume scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.3.8 Biopesticides

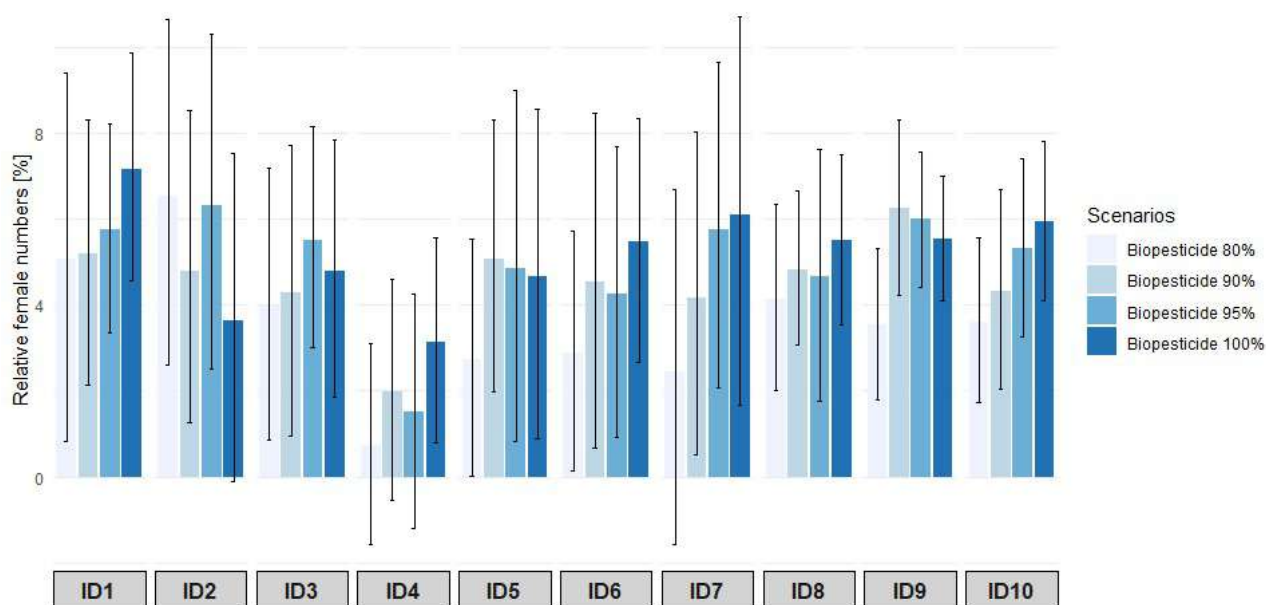


Figure 5.41 Biopesticide scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

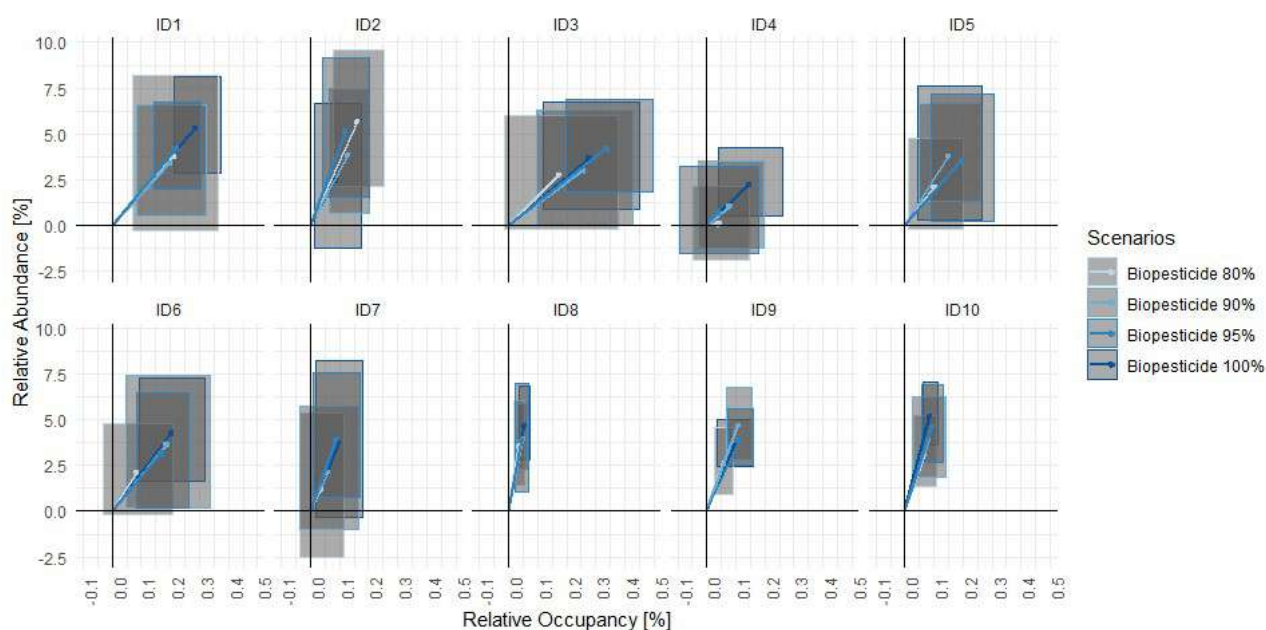


Figure 5.42 Biopesticide scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4 Poland

5.4.1 Flower field margins

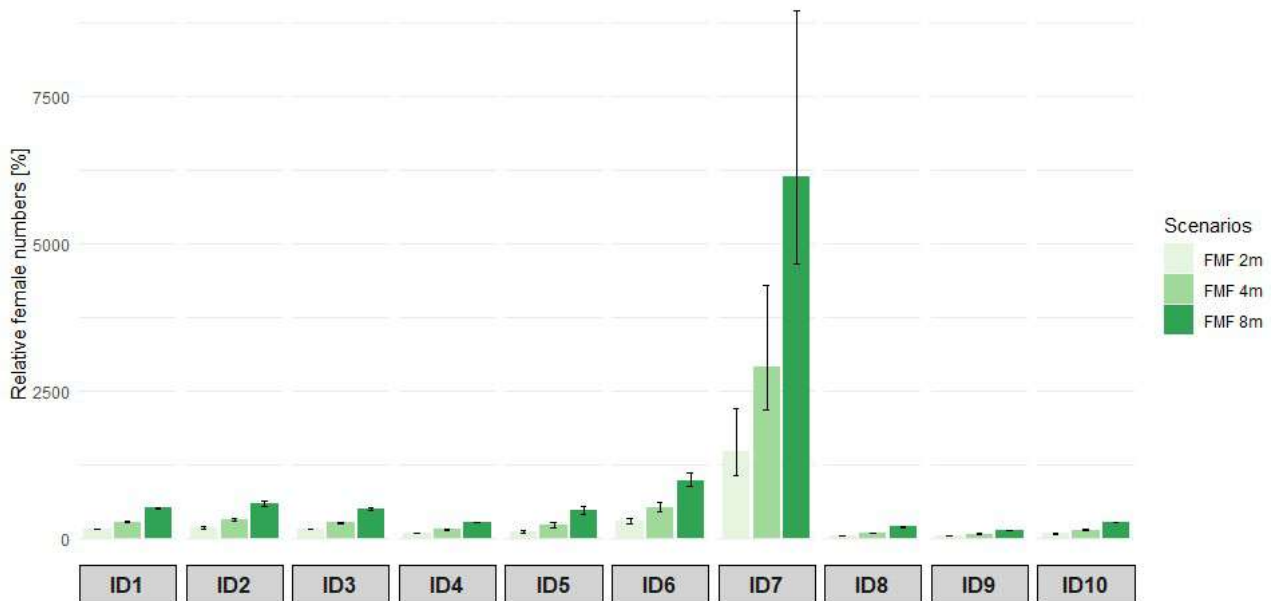


Figure 5.43 Flower field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

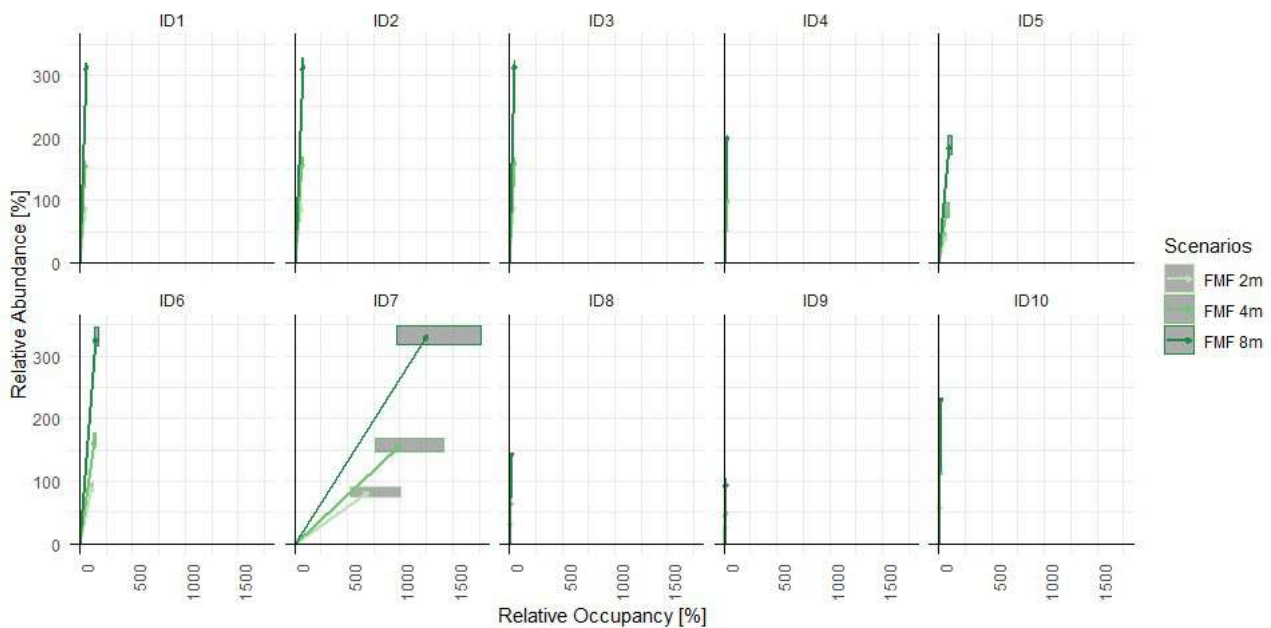


Figure 5.44 Flower field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4.2 Grassy field margins

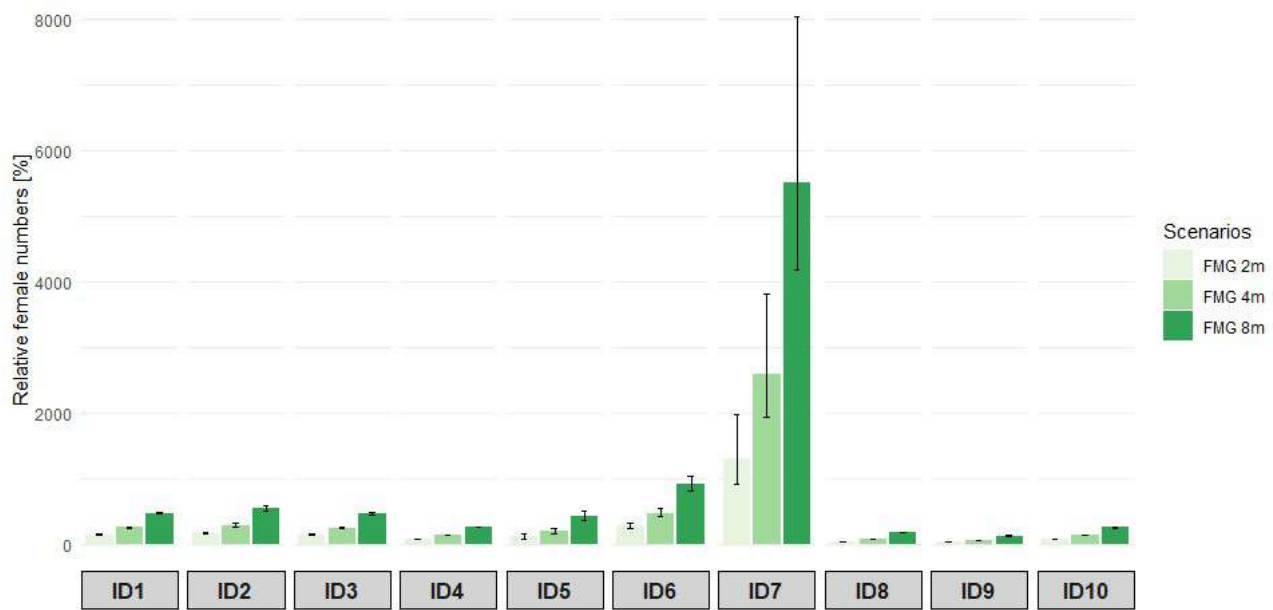


Figure 5.45 Grassy field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

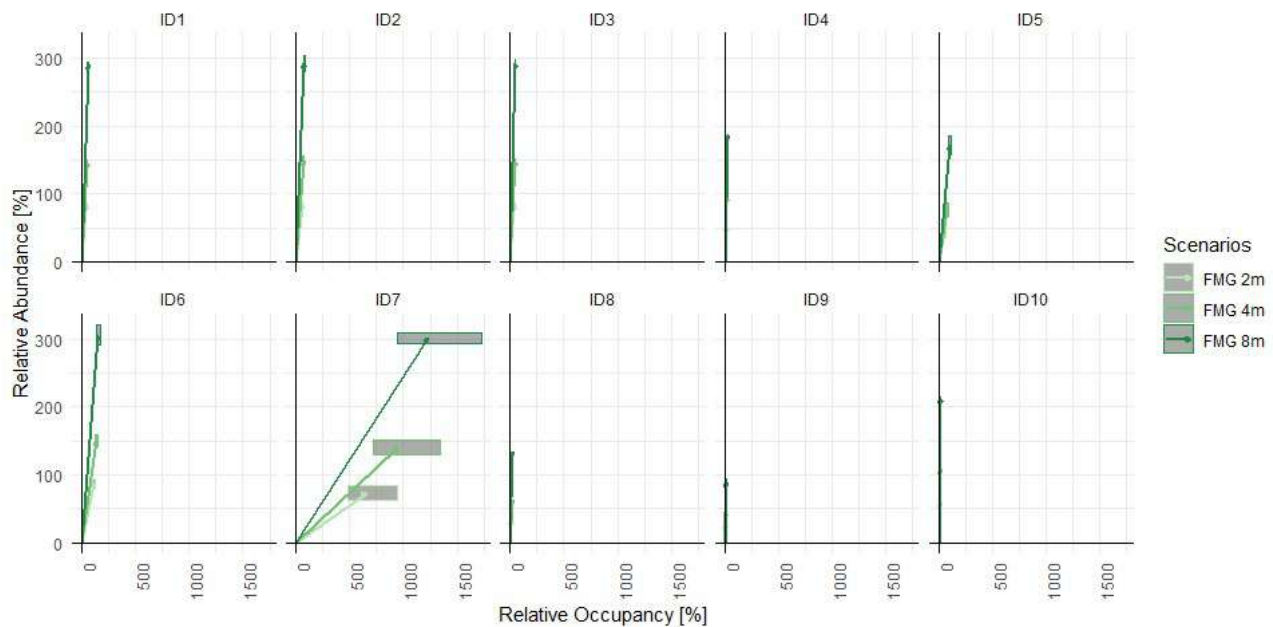


Figure 5.46 Grassy field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4.3 Mixed field margins

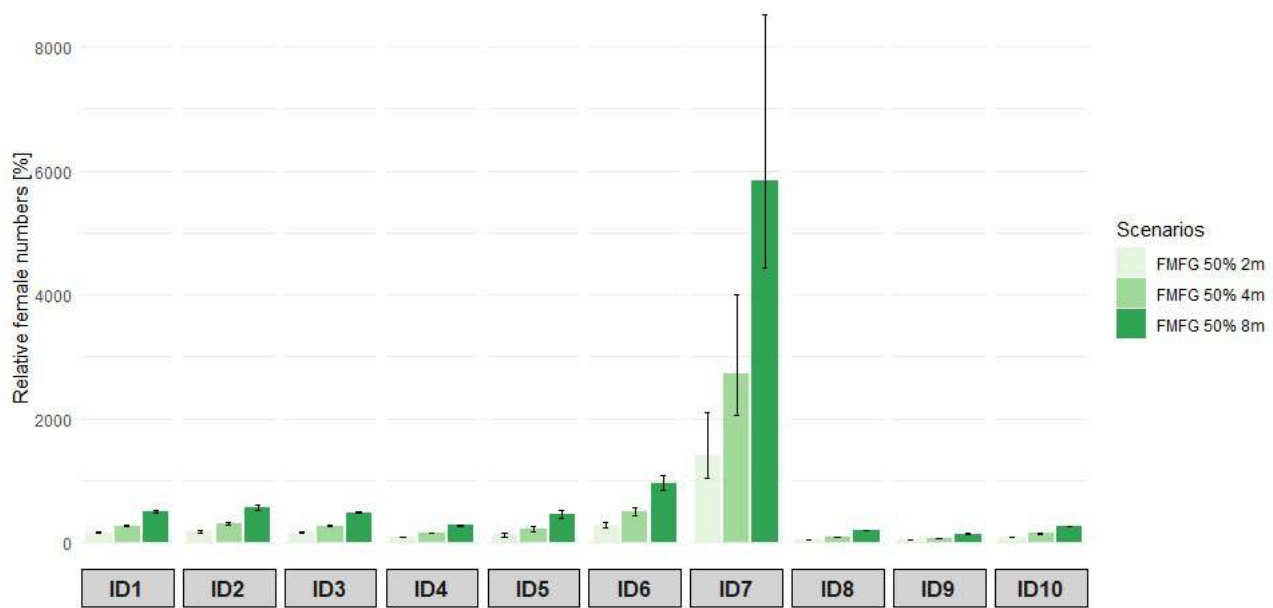


Figure 5.47 Mixed field margins scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

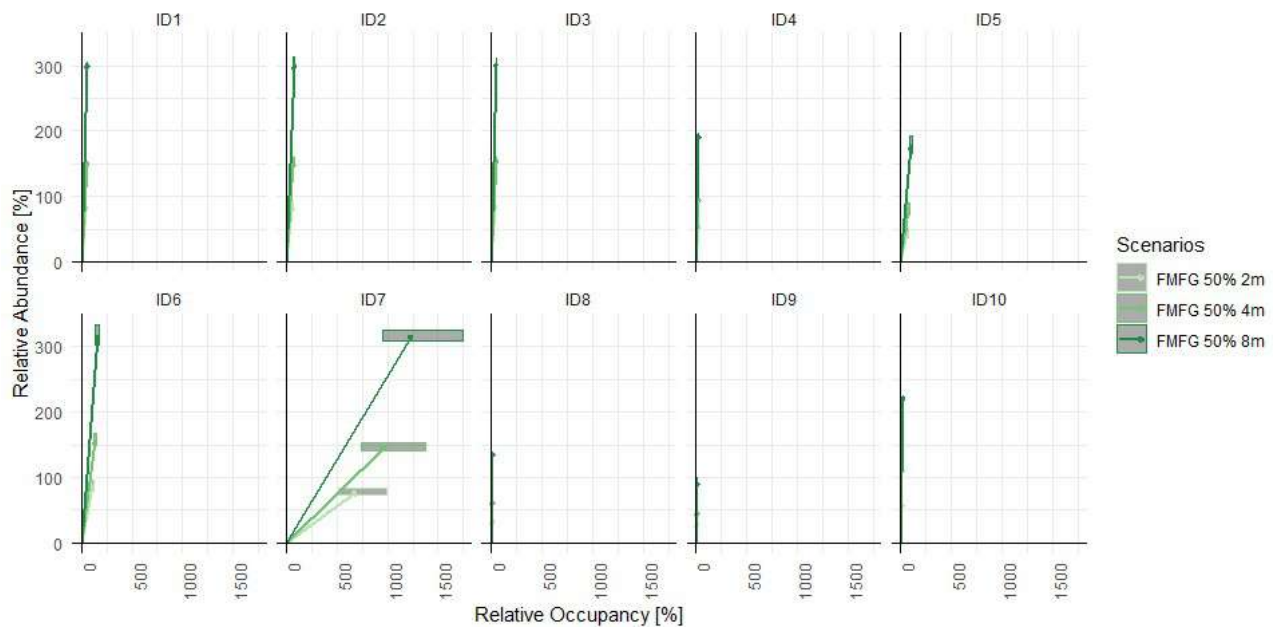


Figure 5.48 Mixed field margins with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4.4 Flower, grassy and mixed field margins

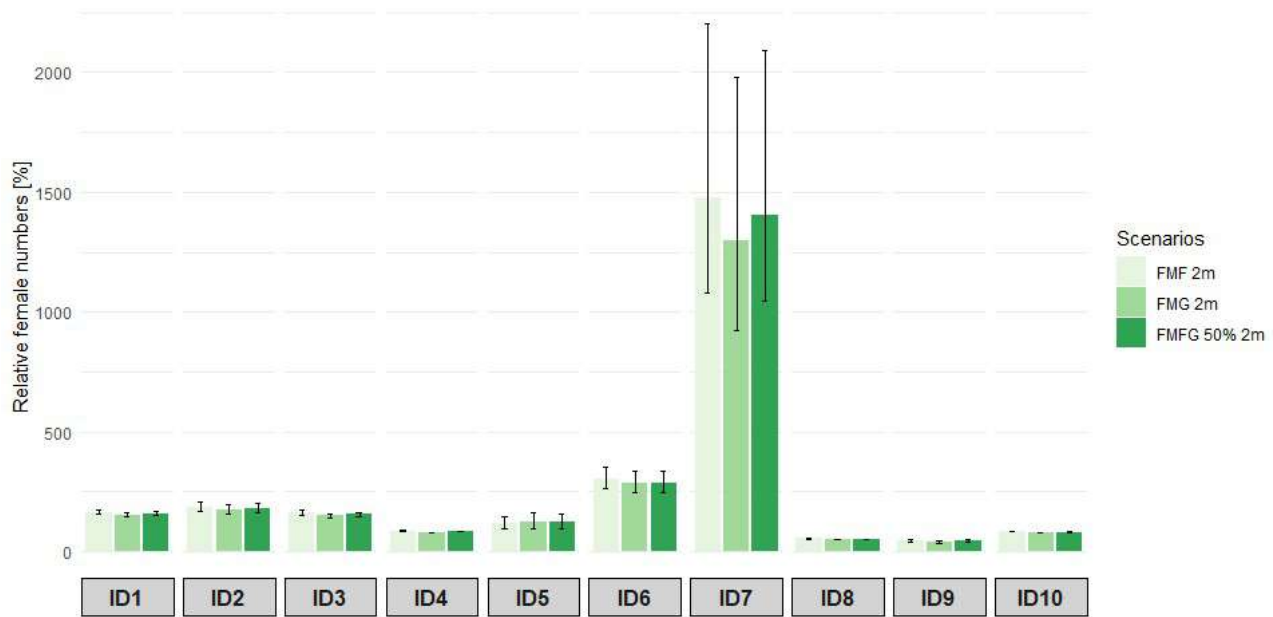


Figure 5.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

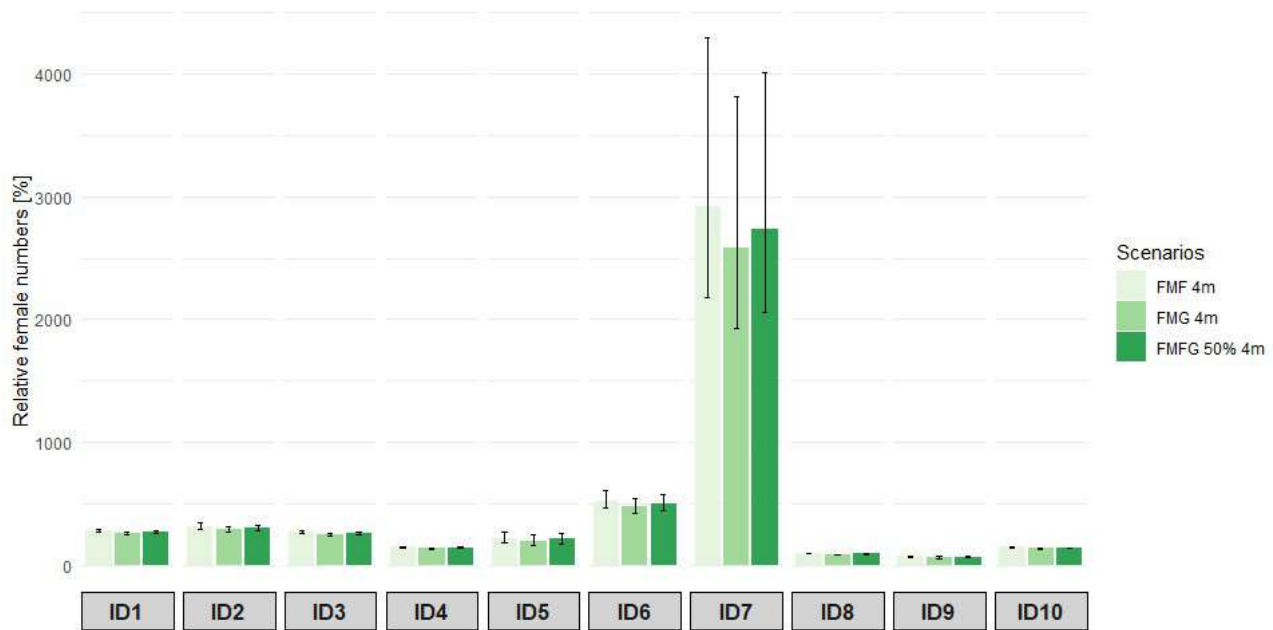


Figure 5.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

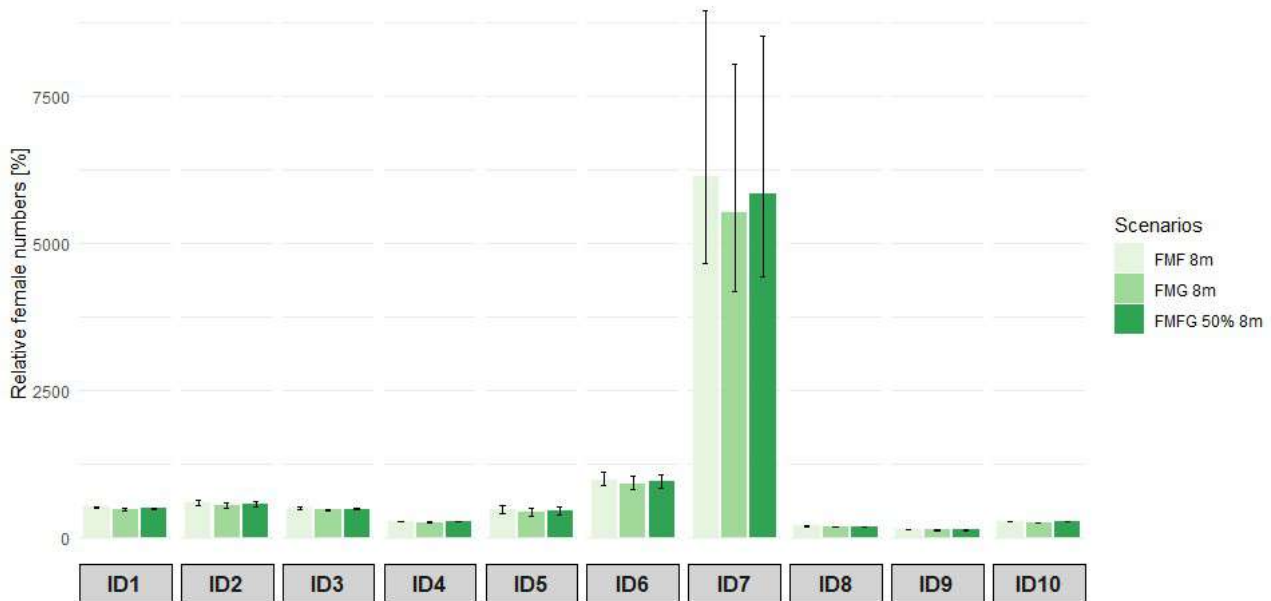


Figure 5.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

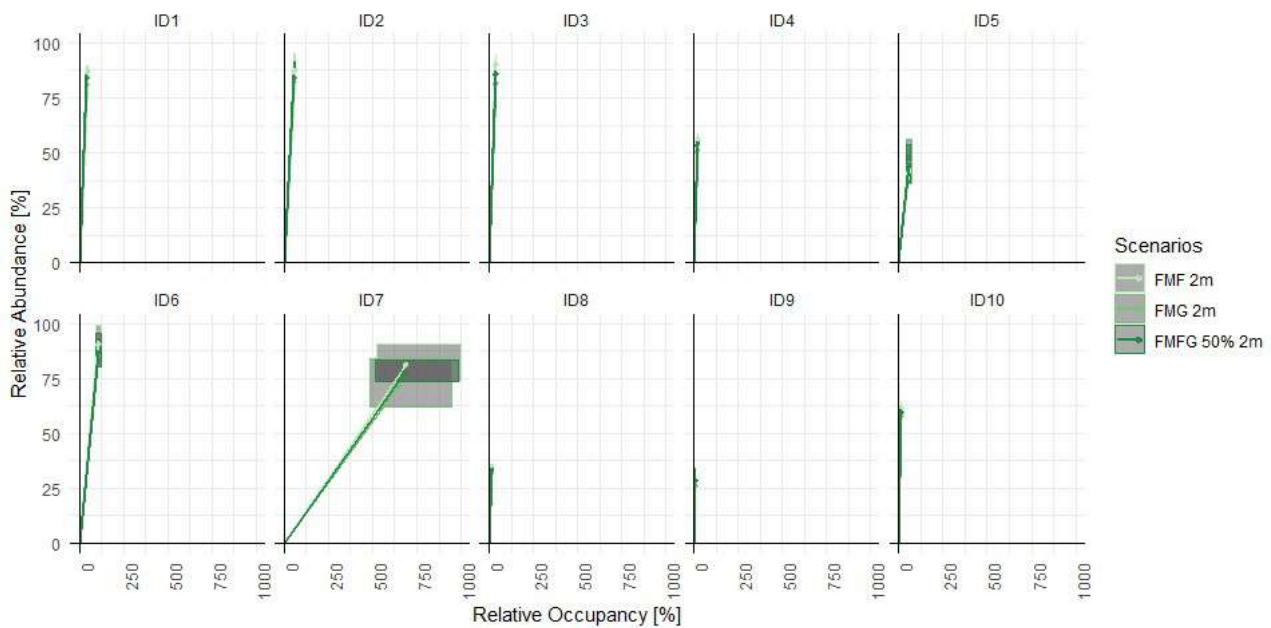


Figure 5.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

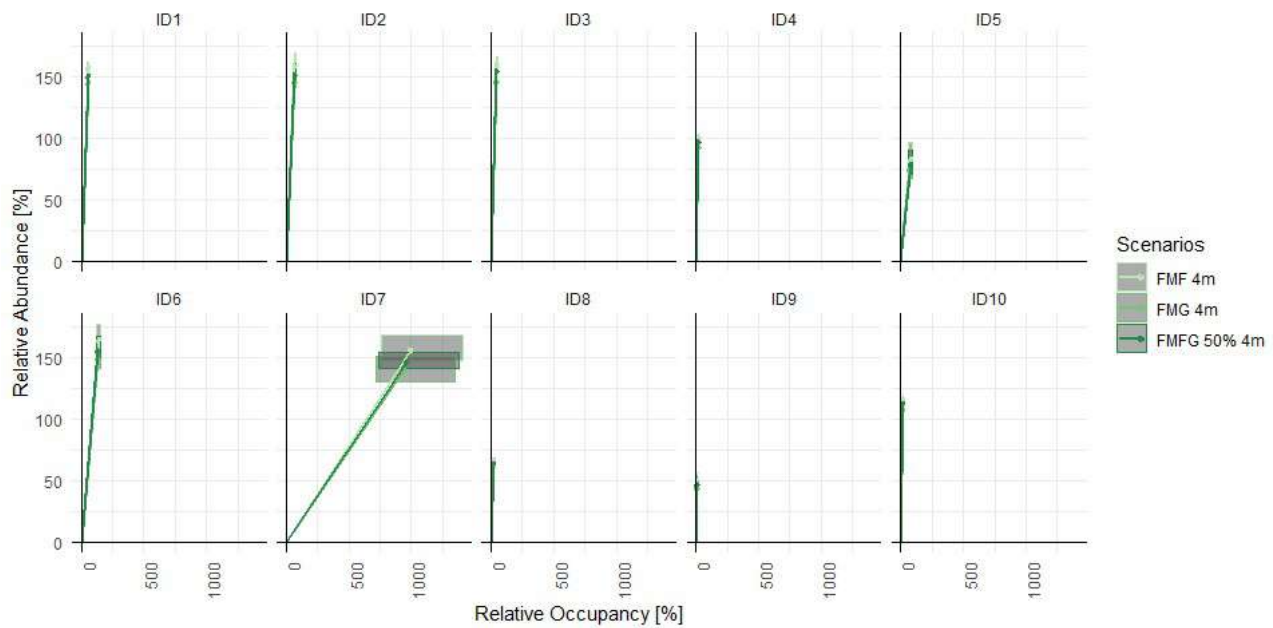


Figure 5.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes..

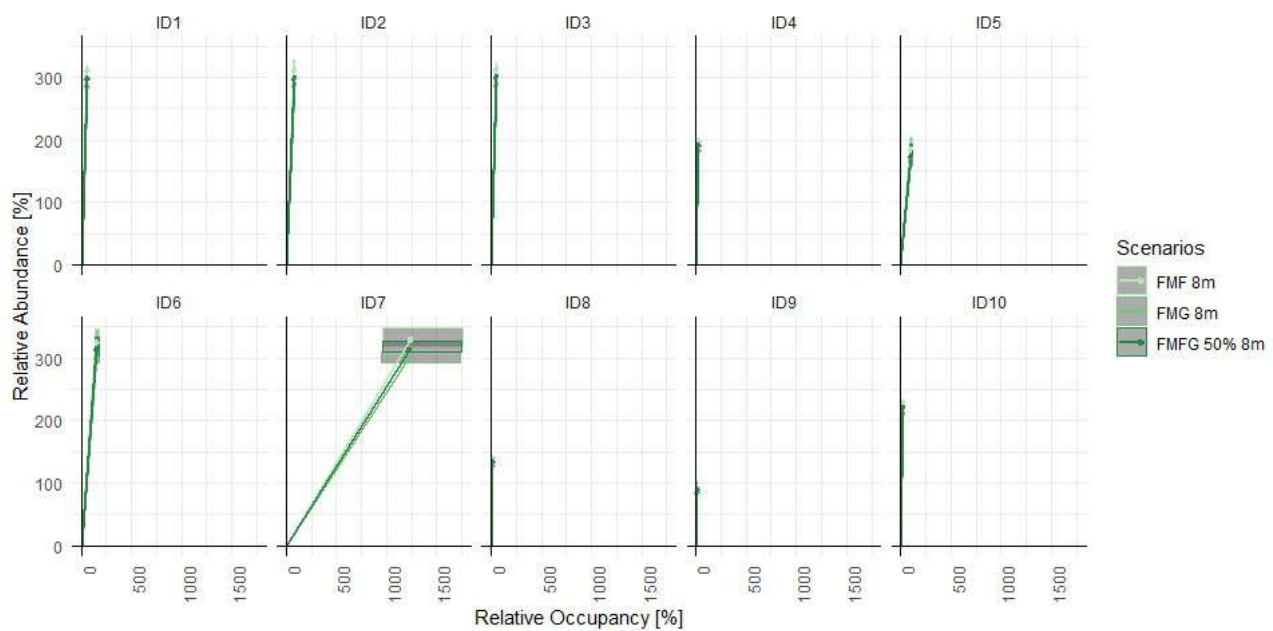


Figure 5.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4.5 Setaside

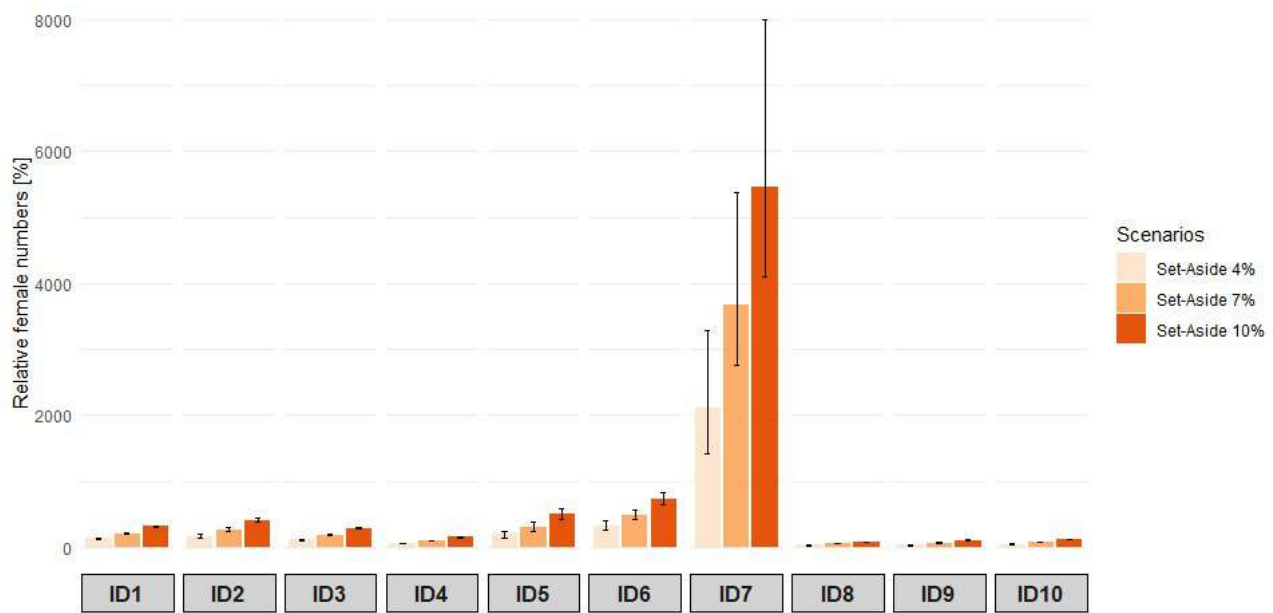


Figure 5.55 Setaside scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

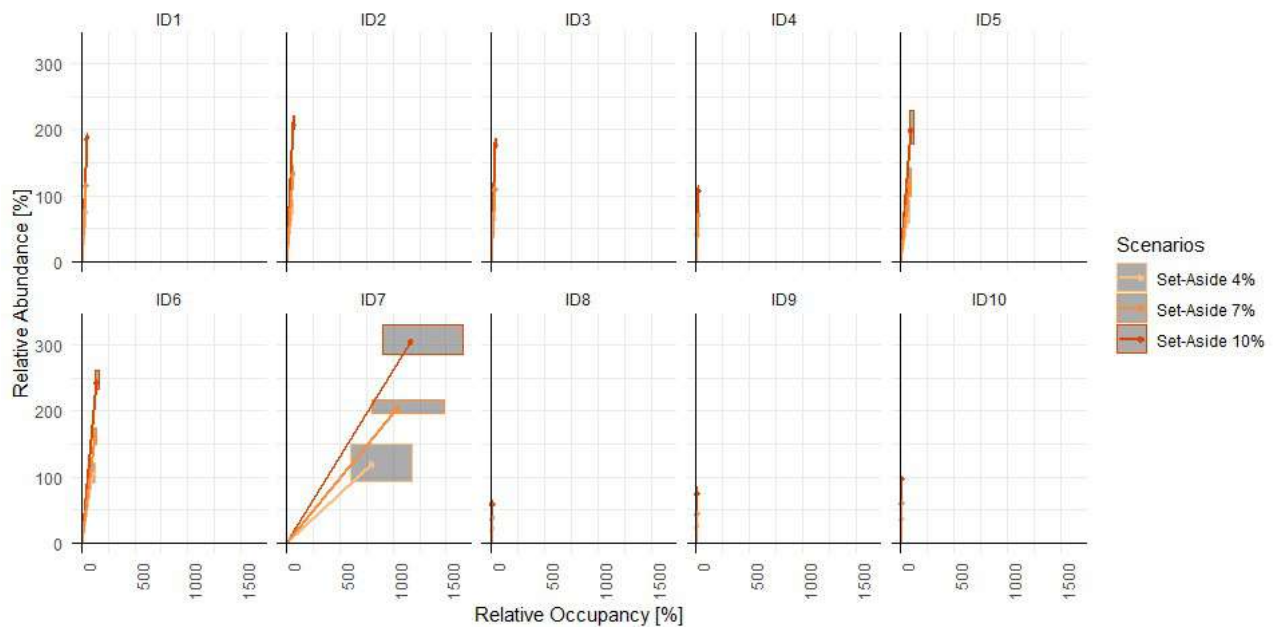


Figure 5.56 Setaside scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4.6 Legume

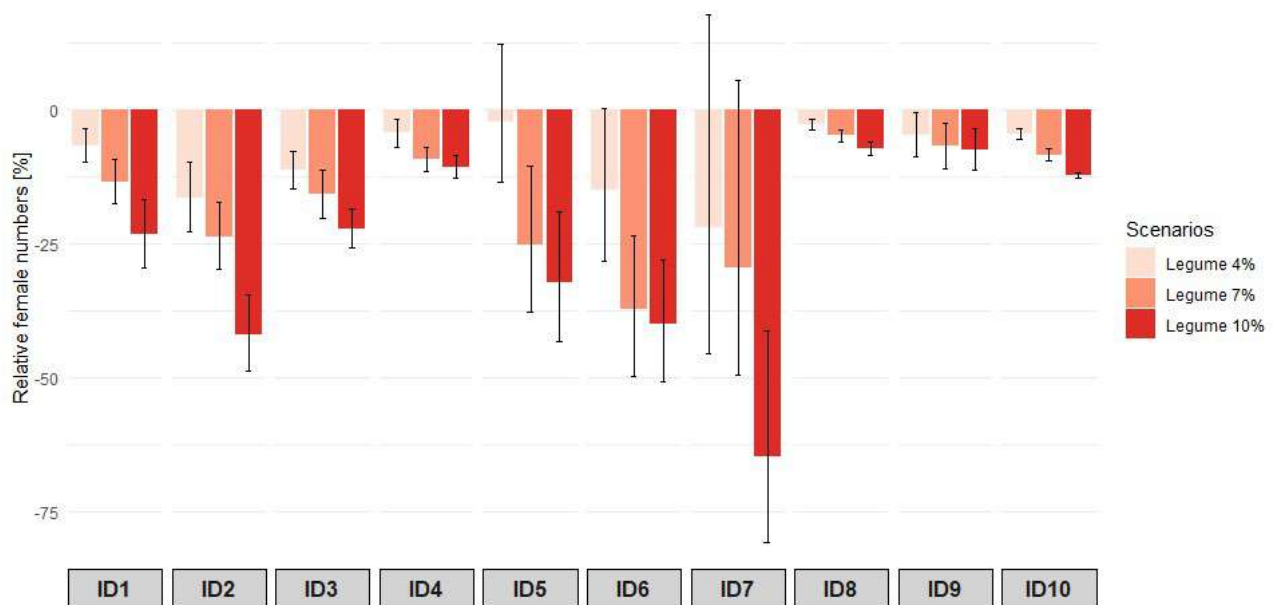


Figure 5.57 Legume scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

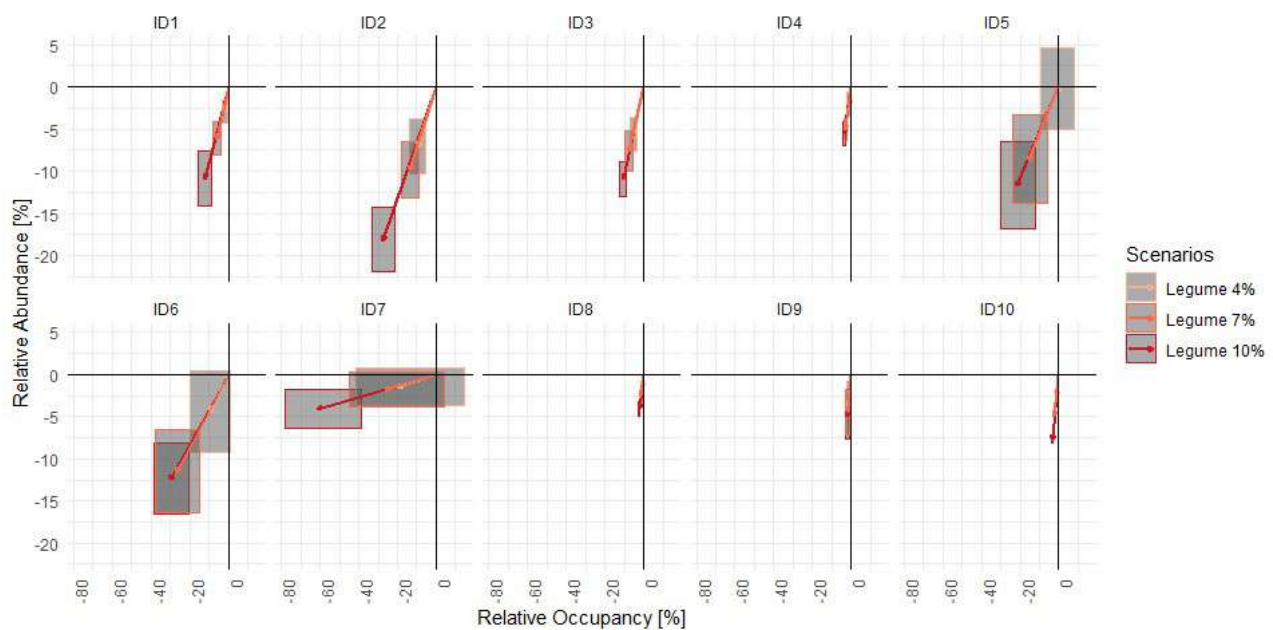


Figure 5.58 Legume scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.4.7 Biopesticides

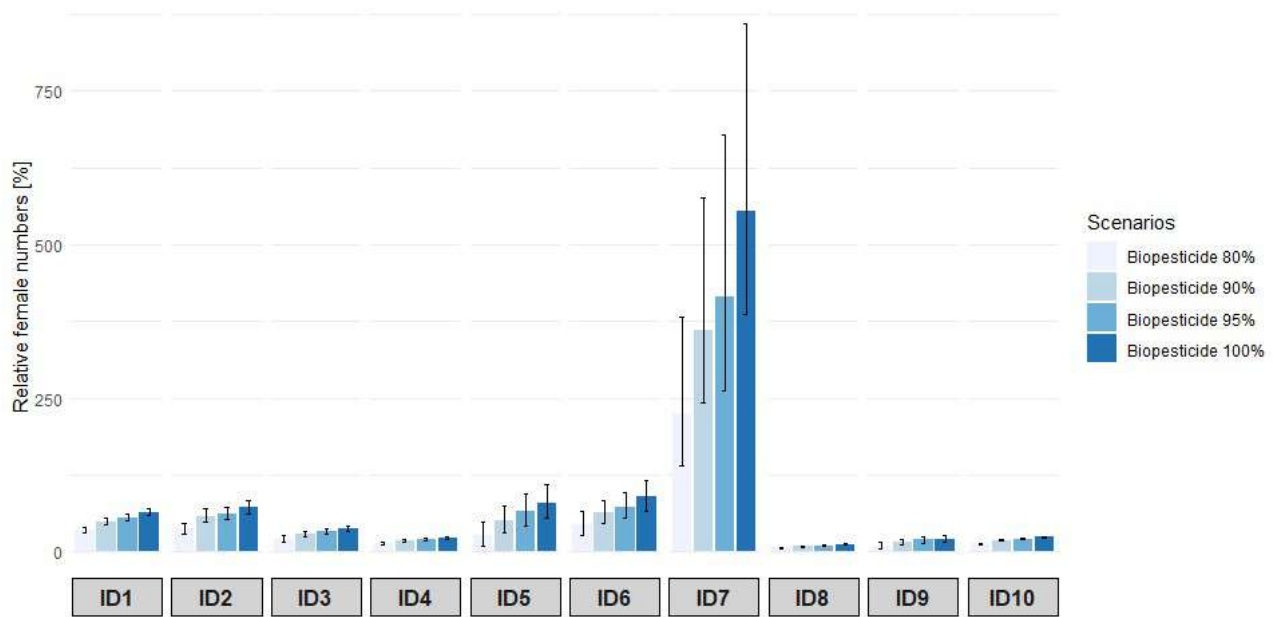


Figure 5.59 Biopesticide scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each landscape in Poland.

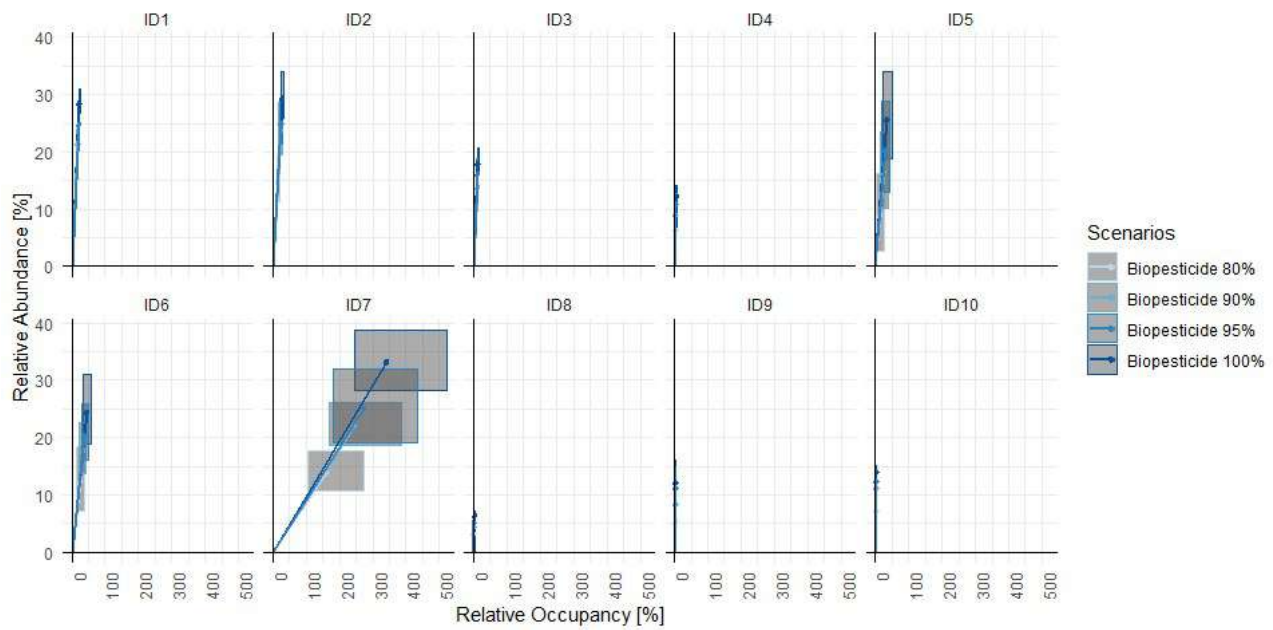


Figure 5.60 Biopesticide scenario with relative change in occupancy and abundance of female *Erigone* compared to baseline $P(0,0)$ for each landscape in Poland at a 50m resolution. Grey areas indicate standard deviation along both axes.

5.5 Combined landscapes

5.5.1 Crop diversification

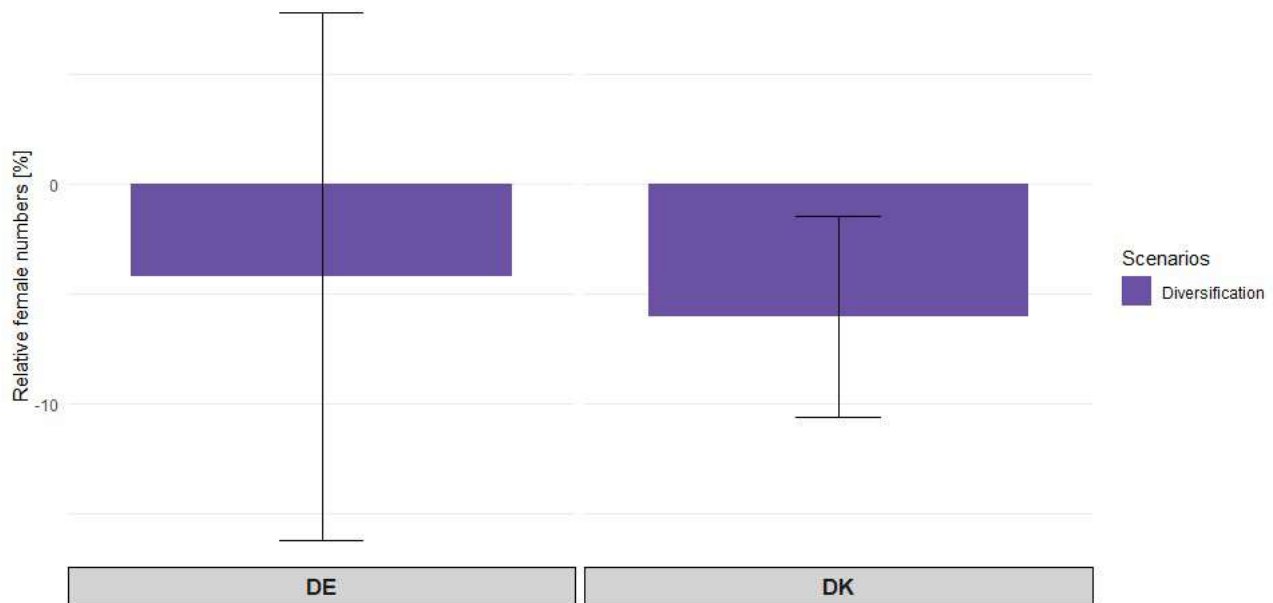


Figure 5.61 Diversification scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each simulated country.

5.5.2 Flower field margins

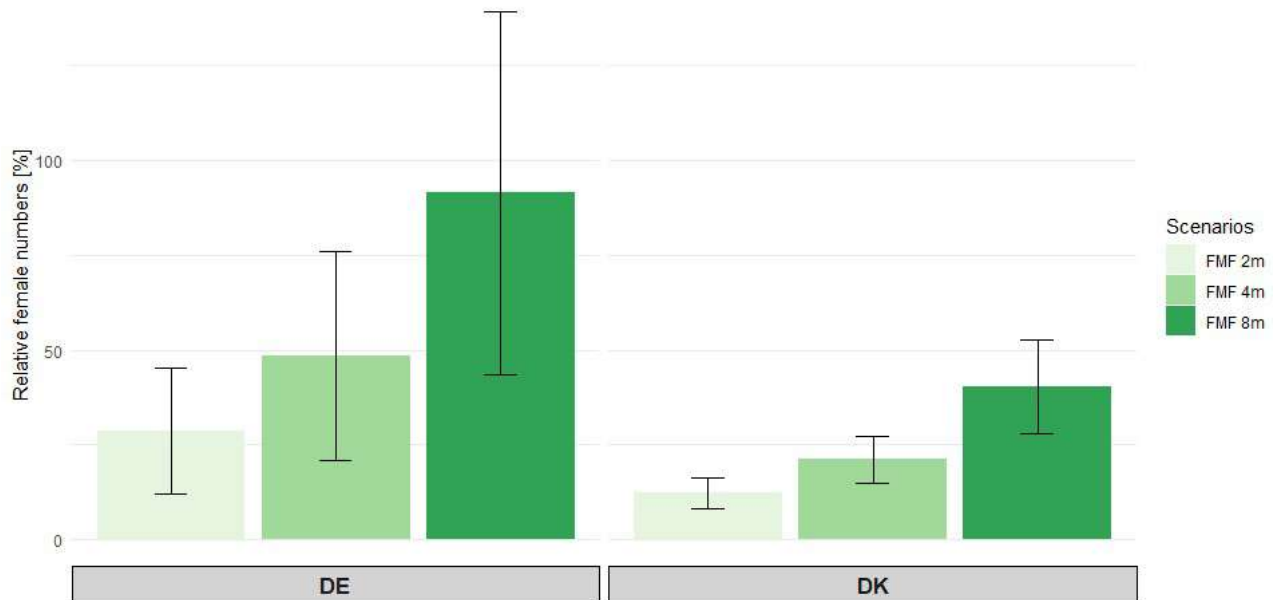


Figure 5.62 Flower field margins with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

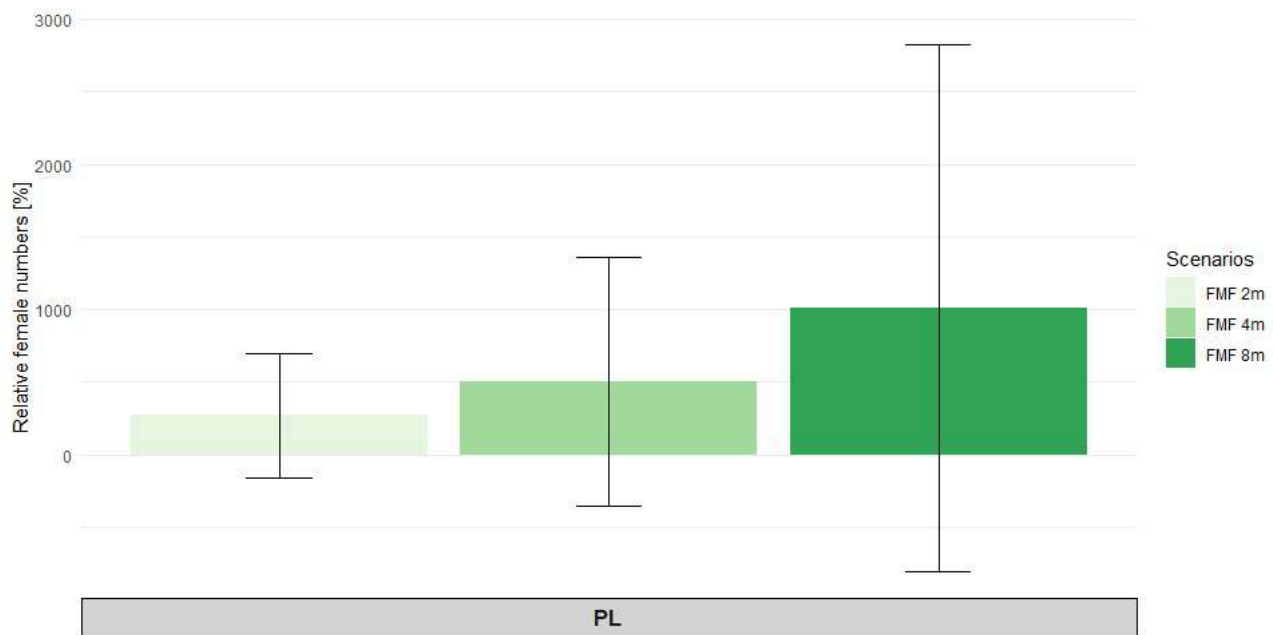


Figure 5.63 Flower field margins with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

5.5.3 Grassy field margins

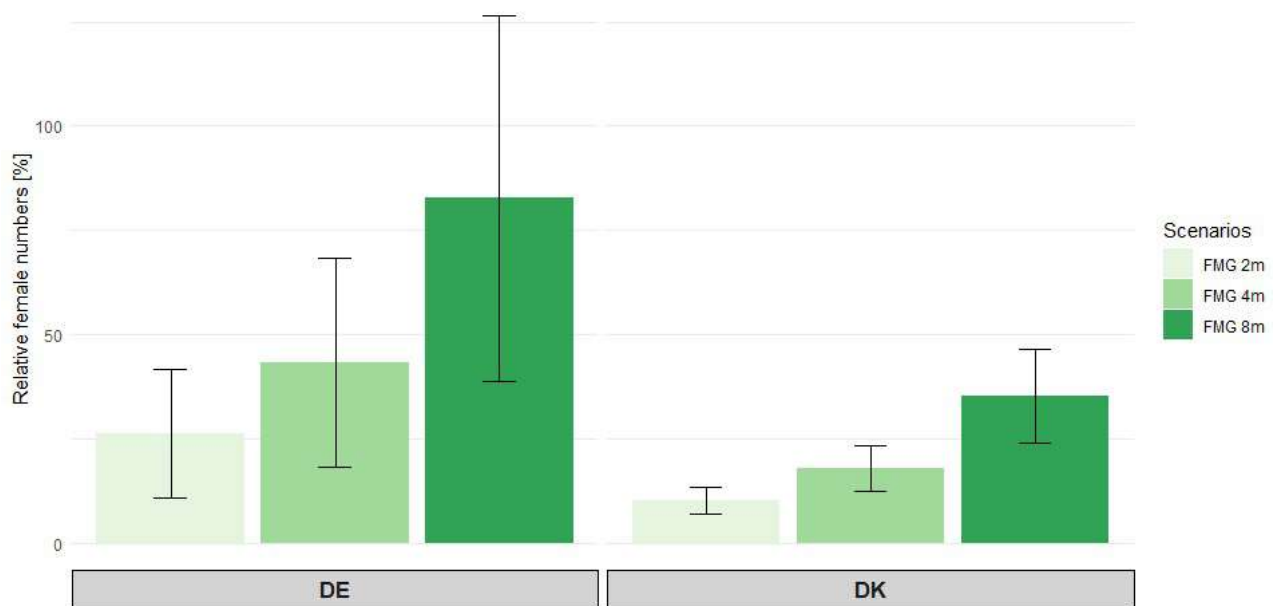


Figure 5.64 Grassy field margins with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

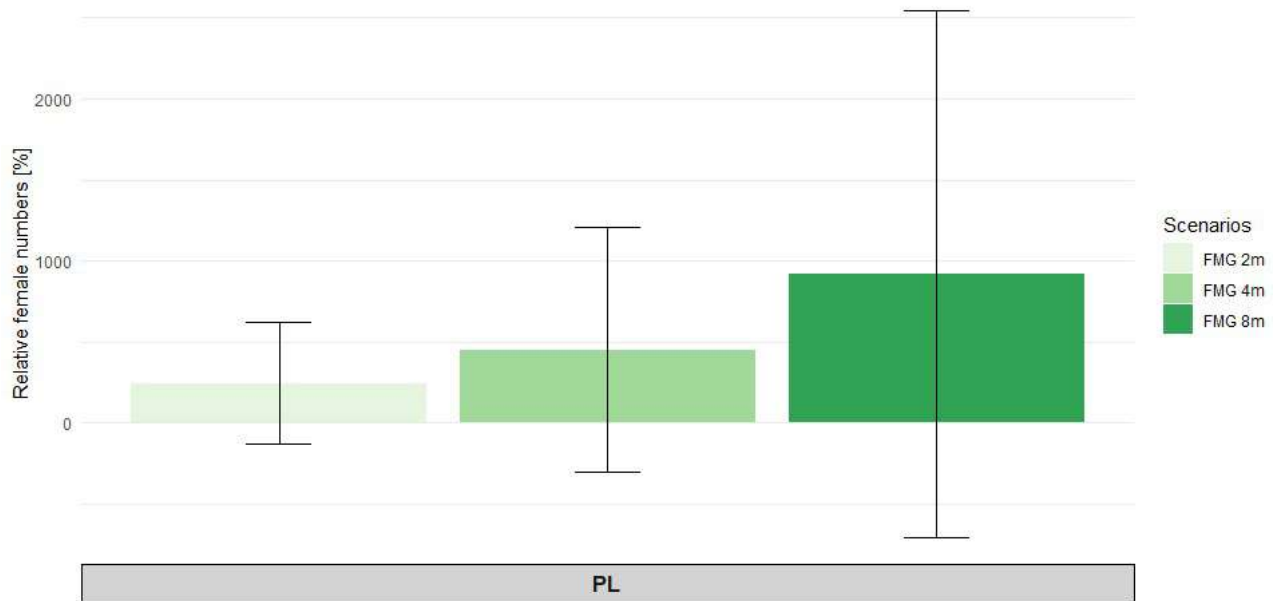


Figure 5.65 Grassy field margins with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

5.5.4 Mixed field margins

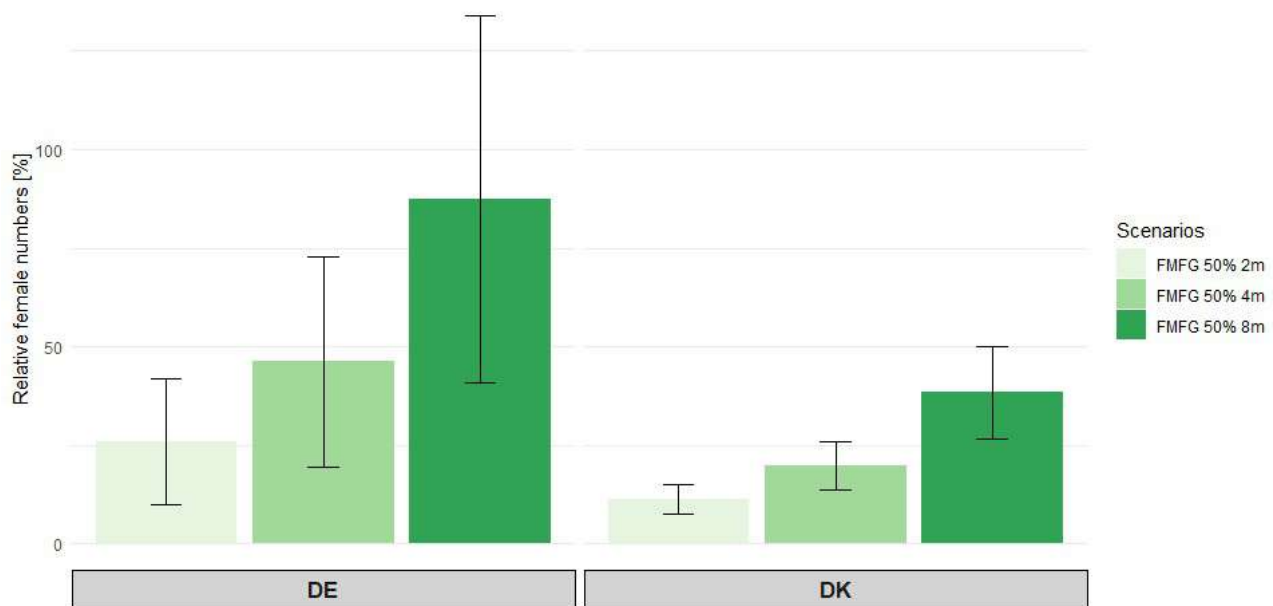


Figure 5.66 Mixed field margins with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

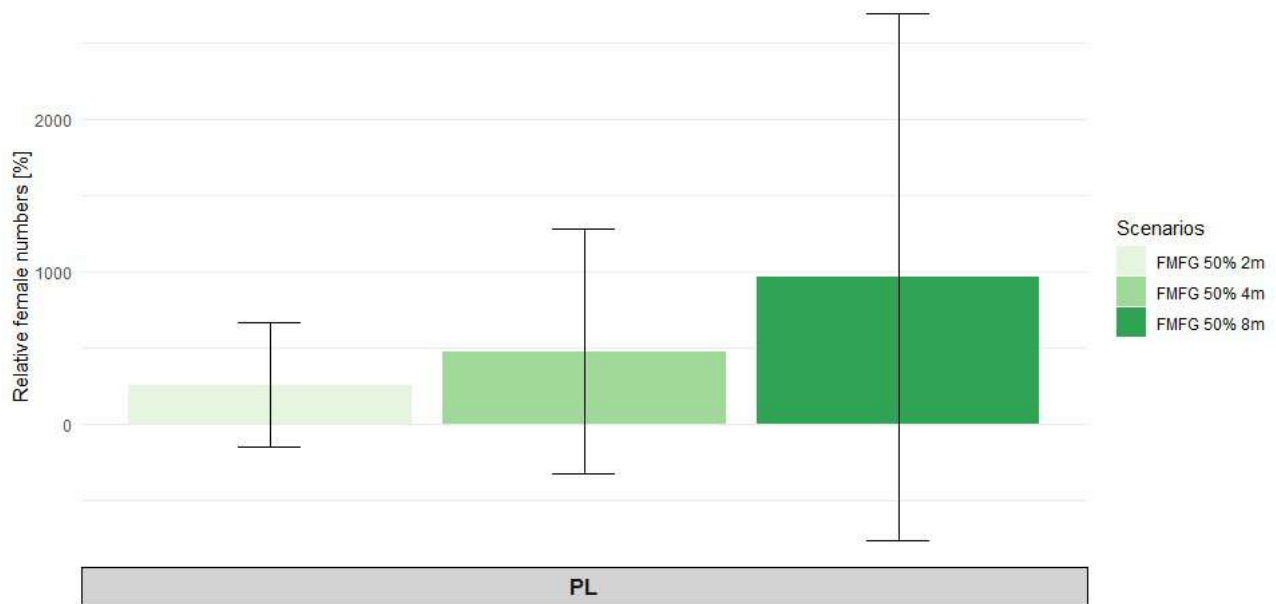


Figure 5.67 Mixed field margins with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

5.5.5 Flower, grassy and mixed margins

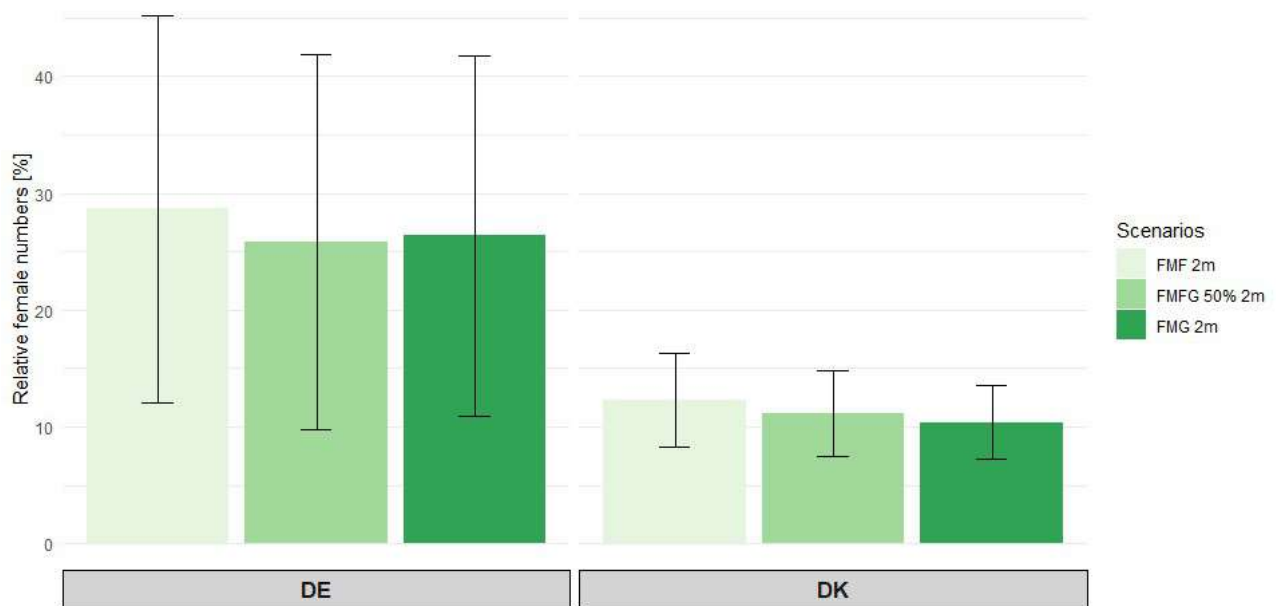


Figure 5.68 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

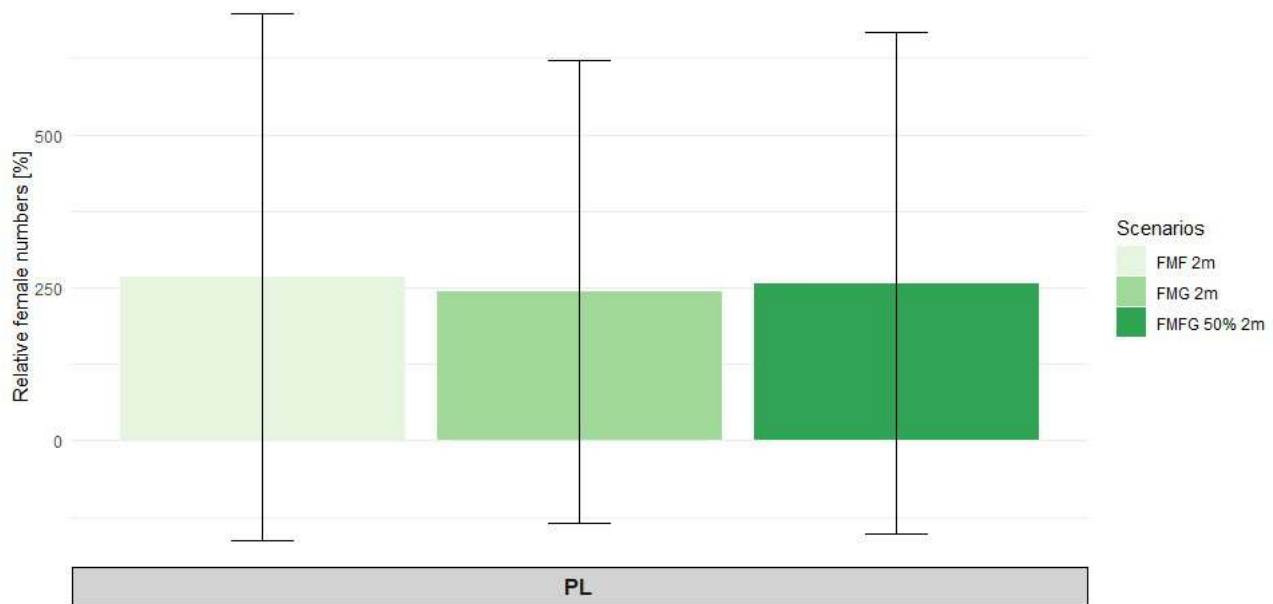


Figure 5.69 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

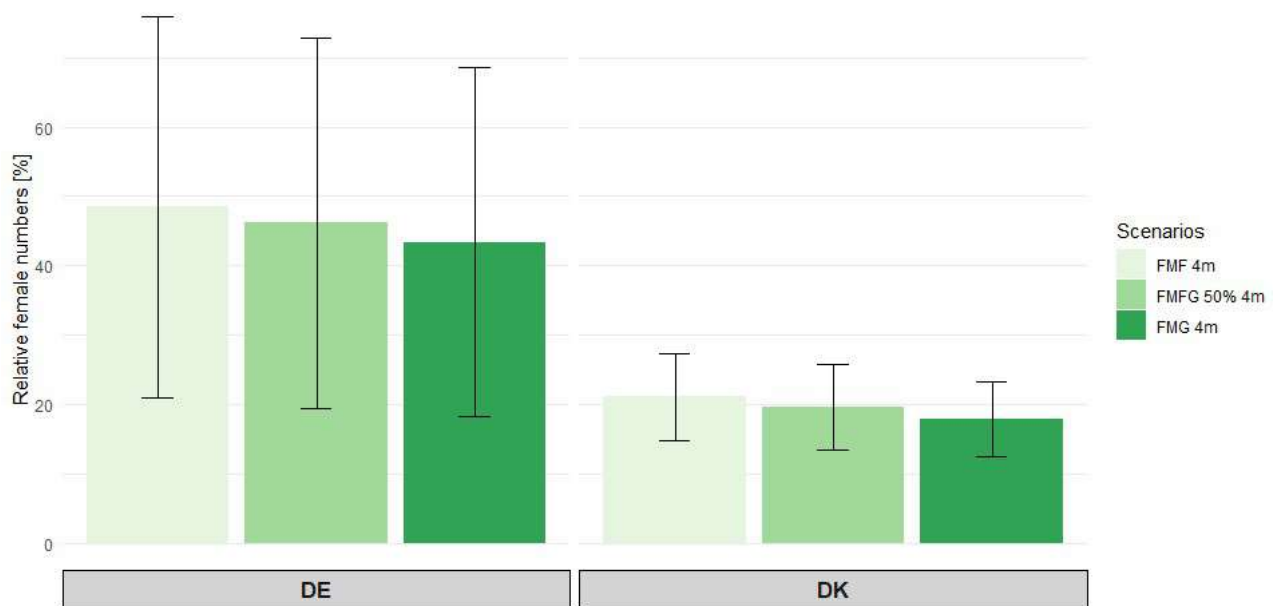


Figure 5.70 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

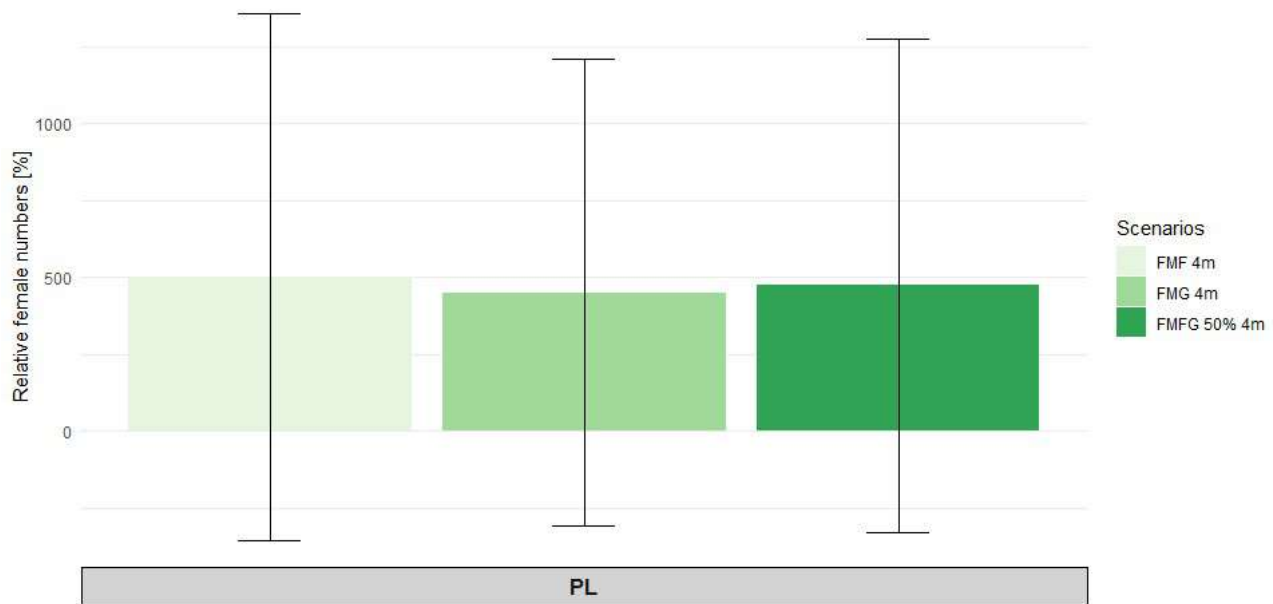


Figure 5.71 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

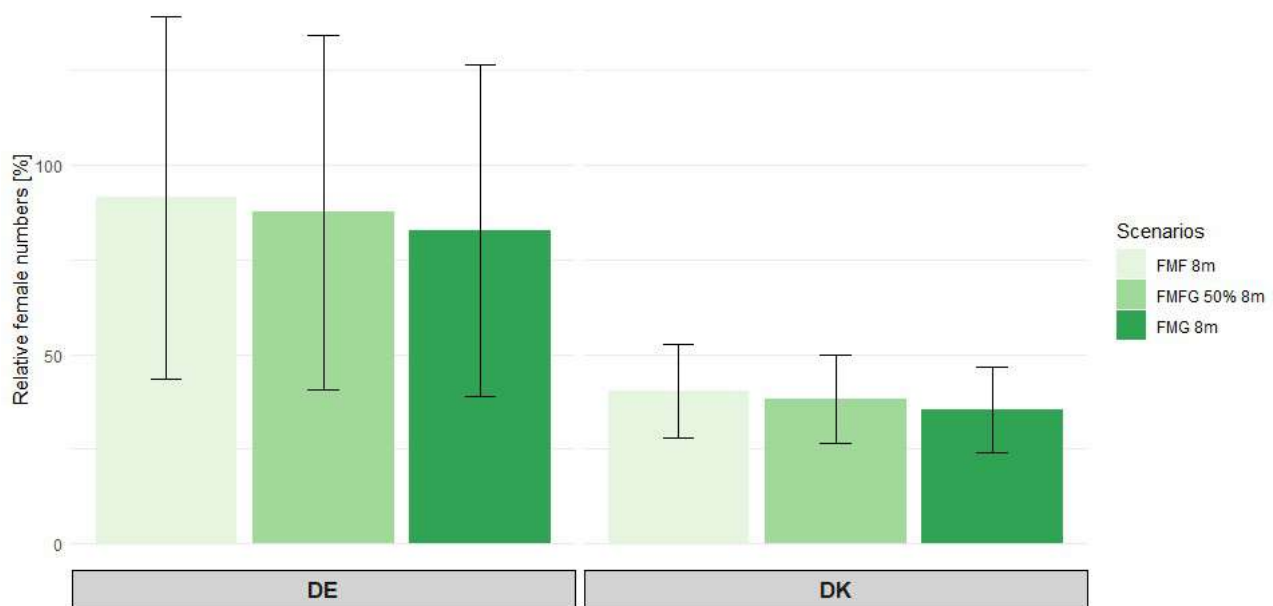


Figure 5.72 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

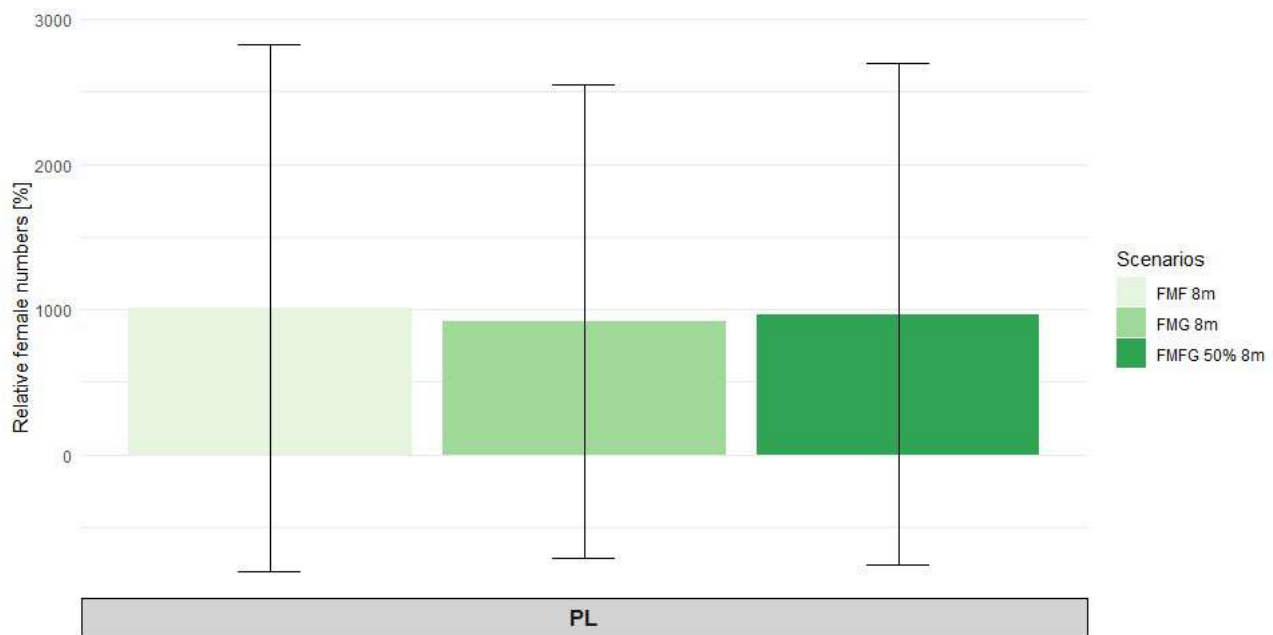


Figure 5.73 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

5.5.6 Setaside

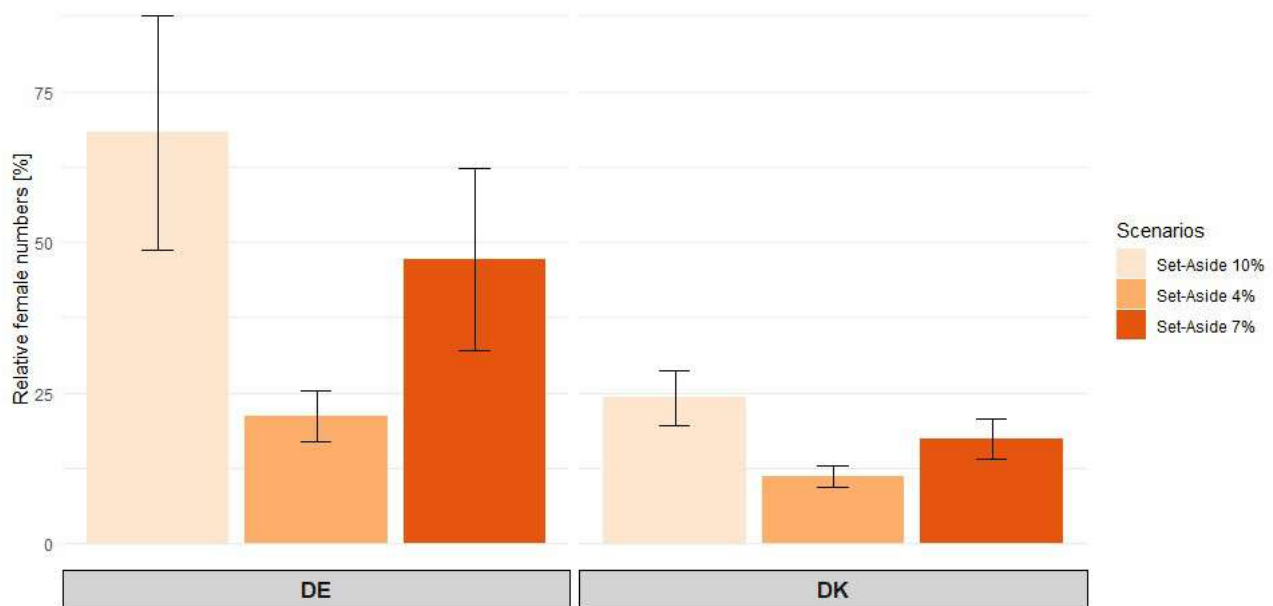


Figure 5.74 Setaside scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

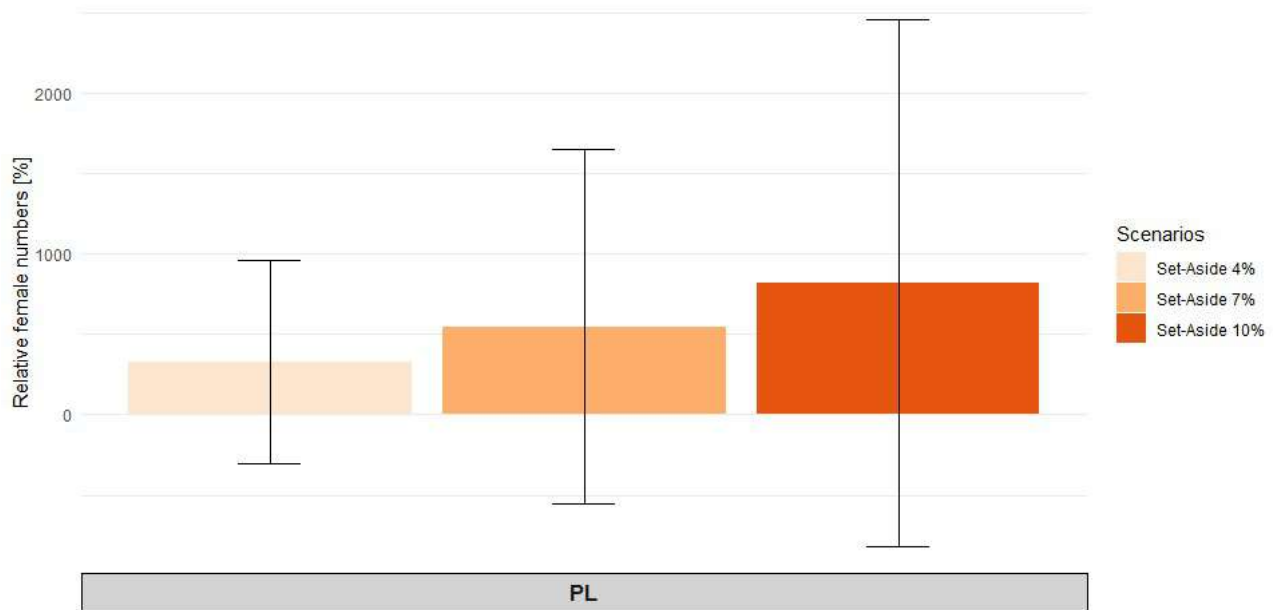


Figure 5.75 Setaside scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

5.5.7 Legume

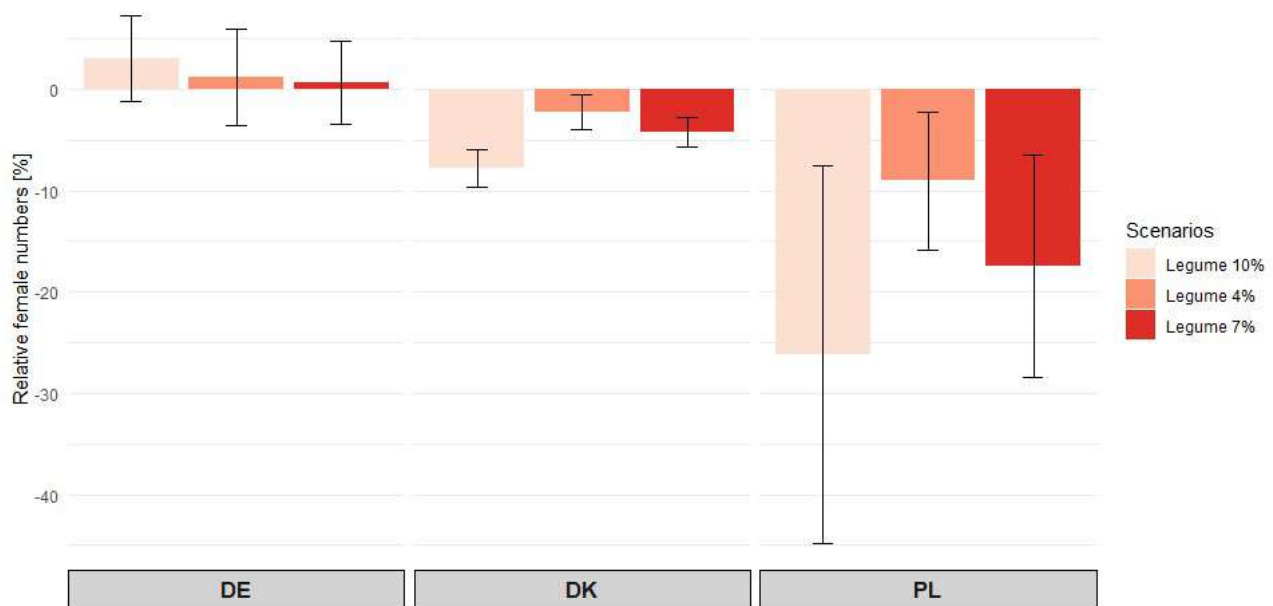


Figure 5.76 Legume scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for each simulated country.

5.5.8 Biopesticides

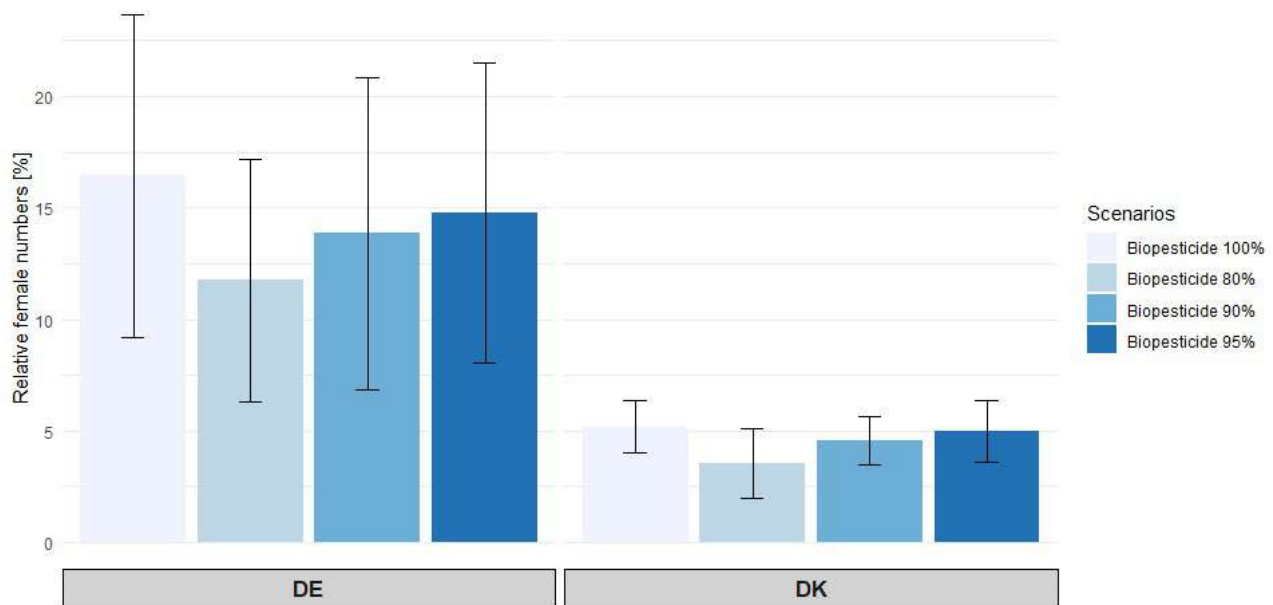


Figure 5.77 Biopesticide scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Germany and Denmark.

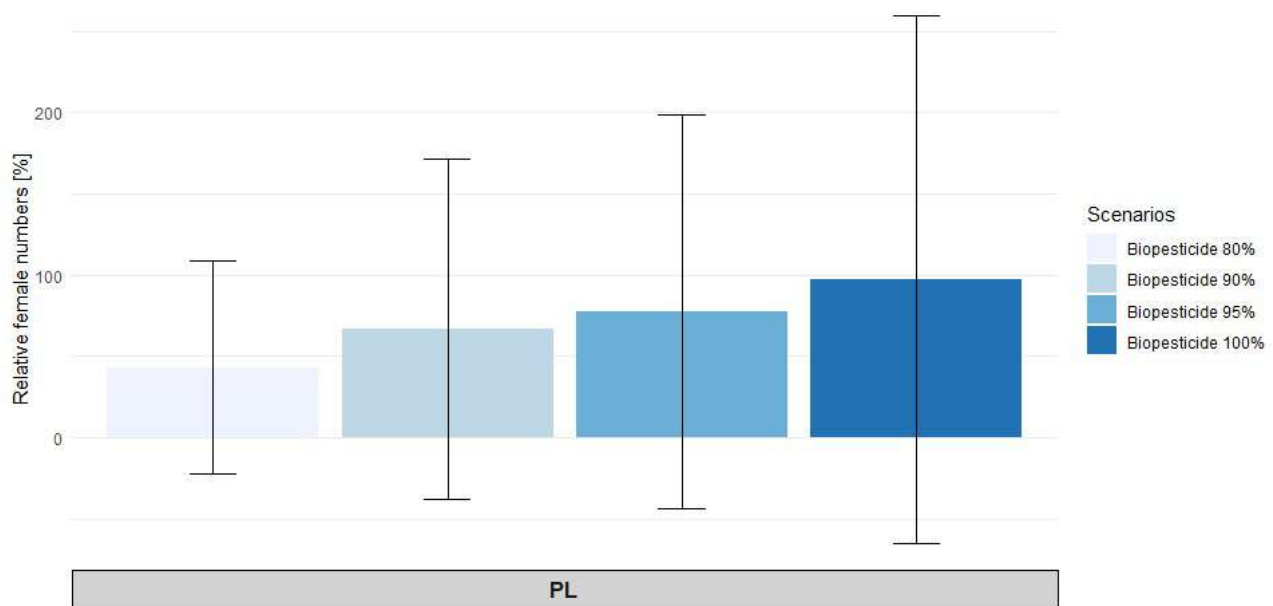


Figure 5.78 Biopesticide scenario with relative change in the number of female *Erigone* compared to baseline and standard deviation presented by error bars for Poland.

5.5.9 Table: Country level overview of scenario effects

Table 5.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for Erigone. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	PL
Diversification	-4% (SD 12%)	-6% (SD 5%)	NA
FMF 2m	29% (SD 17%)	12% (SD 4%)	268% (SD 431%)
FMF 4m	48% (SD 28%)	21% (SD 6%)	502% (SD 859%)
FMF 8m	91% (SD 48%)	40% (SD 13%)	1011% (SD 1818%)
FMG 2m	26% (SD 15%)	10% (SD 3%)	244% (SD 378%)
FMG 4m	43% (SD 25%)	18% (SD 5%)	451% (SD 759%)
FMG 8m	83% (SD 44%)	35% (SD 11%)	919% (SD 1630%)
FMFG 50% 2m	26% (SD 16%)	11% (SD 4%)	257% (SD 410%)
FMFG 50% 4m	46% (SD 27%)	20% (SD 6%)	475% (SD 803%)
FMFG 50% 8m	87% (SD 47%)	38% (SD 12%)	967% (SD 1731%)
Set-Aside 4%	21% (SD 4%)	11% (SD 2%)	327% (SD 635%)
Set-Aside 7%	47% (SD 15%)	17% (SD 3%)	546% (SD 1104%)
Set-Aside 10%	68% (SD 19%)	24% (SD 5%)	821% (SD 1642%)
Legume 4%	1% (SD 5%)	-2% (SD 2%)	-9% (SD 7%)
Legume 7%	1% (SD 4%)	-4% (SD 1%)	-17% (SD 11%)
Legume 10%	3% (SD 4%)	-8% (SD 2%)	-26% (SD 19%)
Biopesticide 80%	12% (SD 5%)	4% (SD 2%)	43% (SD 65%)
Biopesticide 90%	14% (SD 7%)	5% (SD 1%)	67% (SD 105%)
Biopesticide 95%	15% (SD 7%)	5% (SD 1%)	77% (SD 121%)
Biopesticide 100%	16% (SD 7%)	5% (SD 1%)	97% (SD 163%)

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6 LADYBIRD

6.1 Baselines

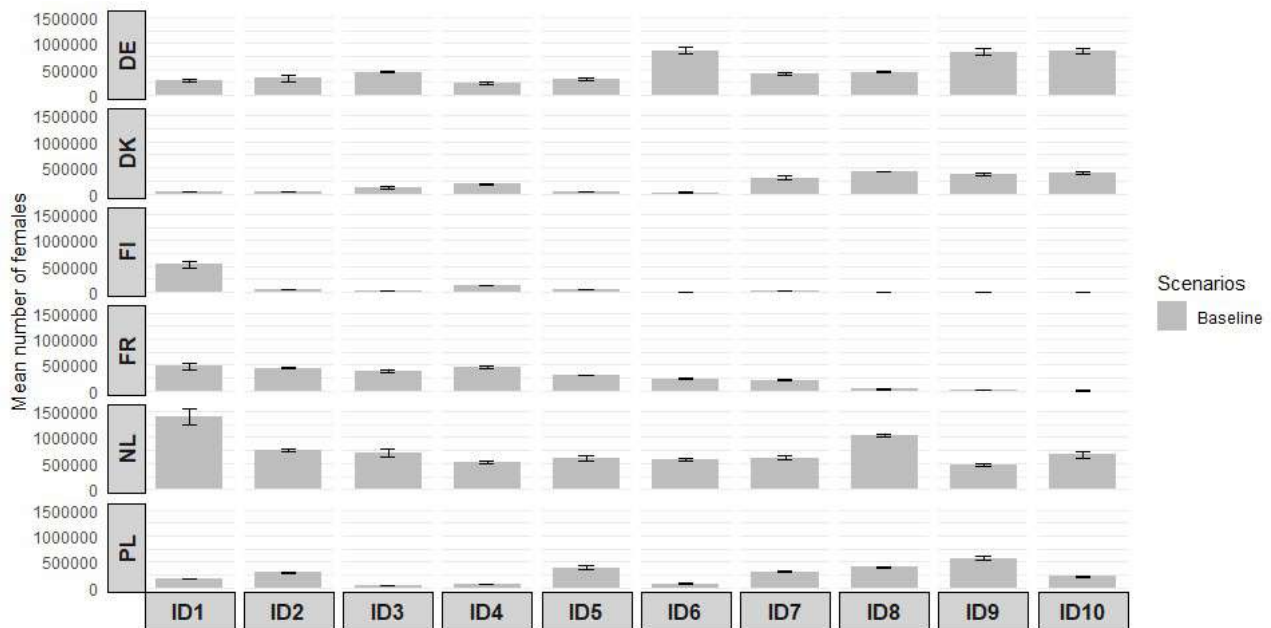


Figure 6.1 Ladybird baselines for each country and landscape.

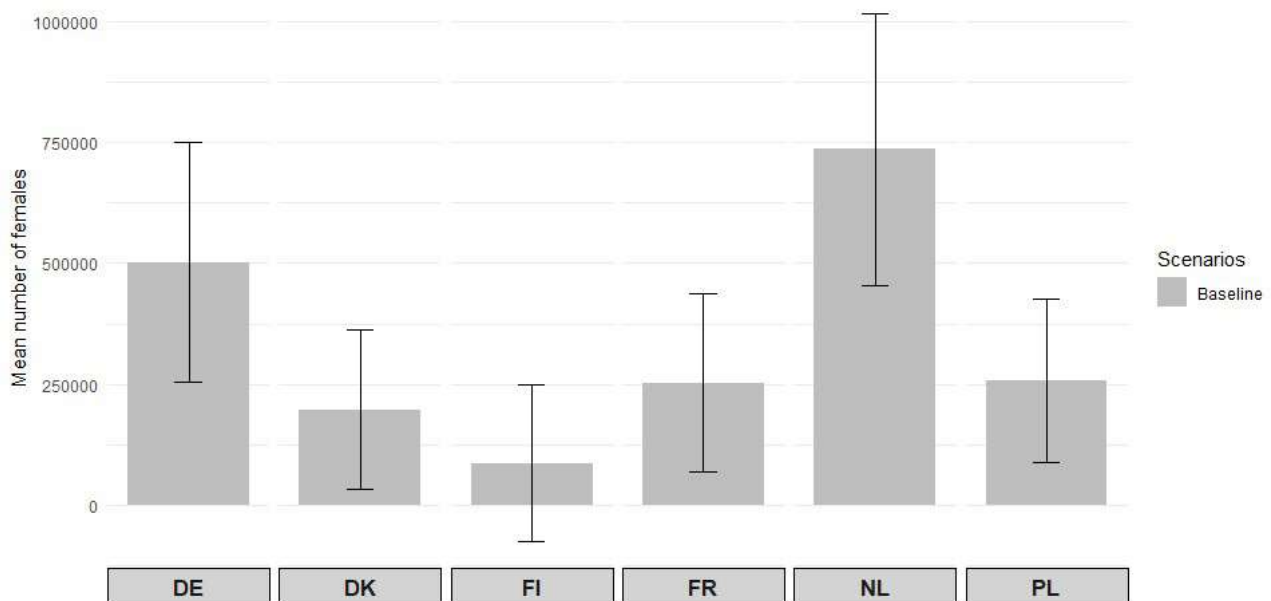


Figure 6.2 Ladybird baselines for each country combined across landscapes.

6.2 Germany

6.2.1 Flower field margins

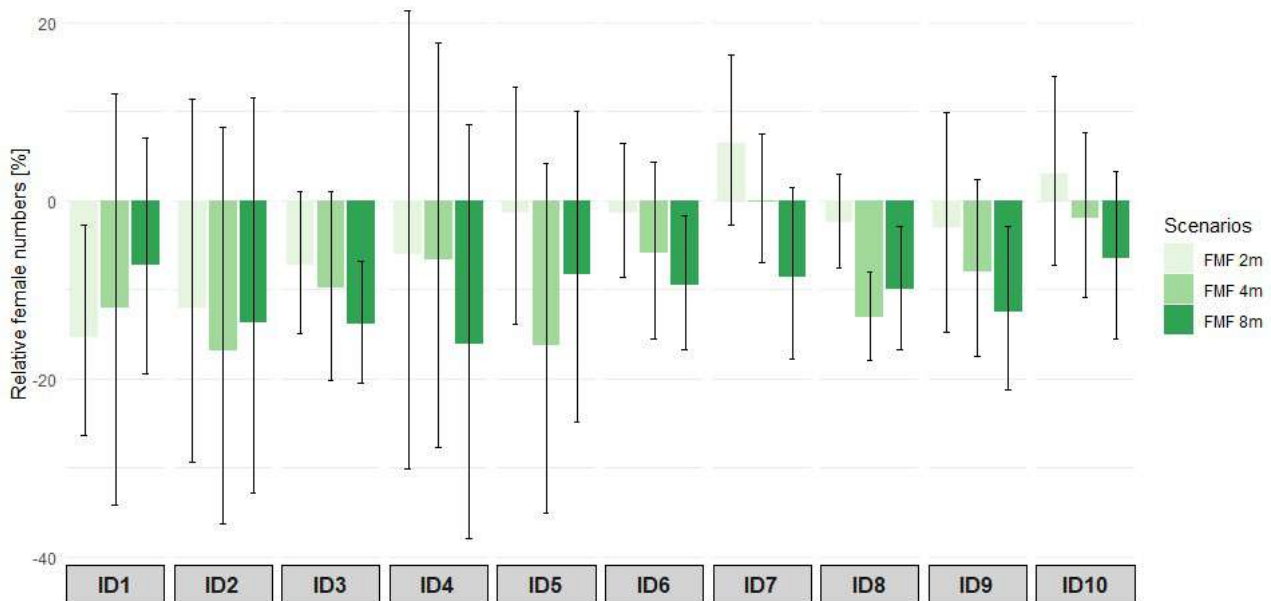


Figure 6.3 Flower field margins scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

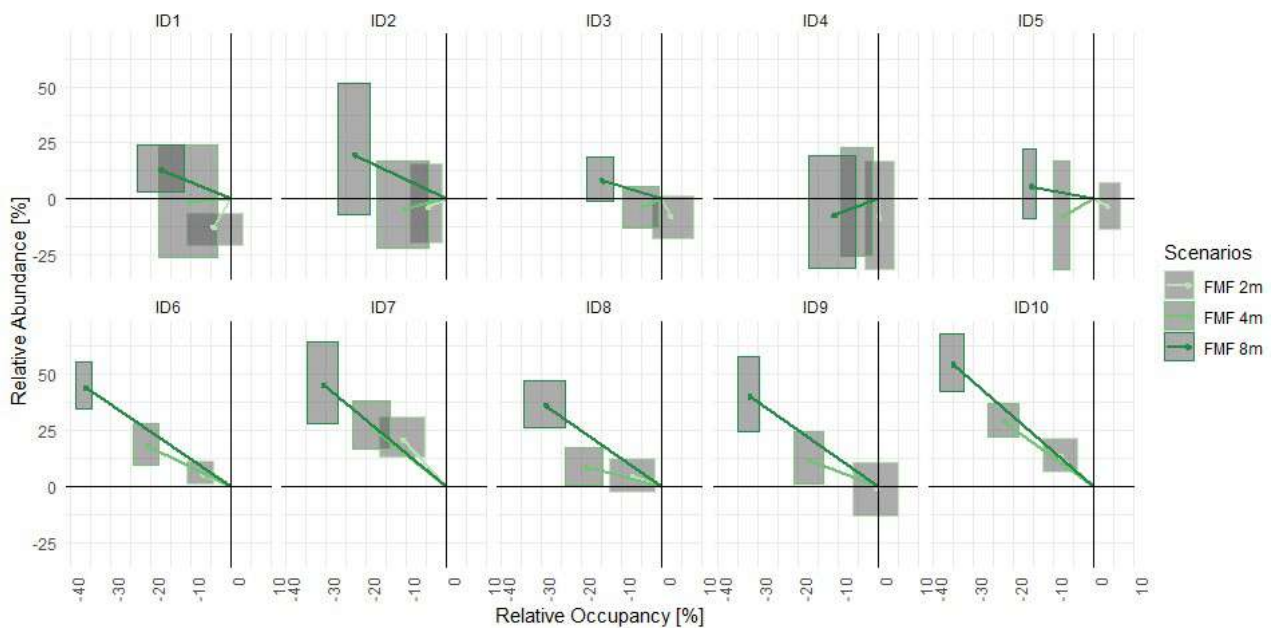


Figure 6.4 Flower field margins with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.2.2 Grassy field margins

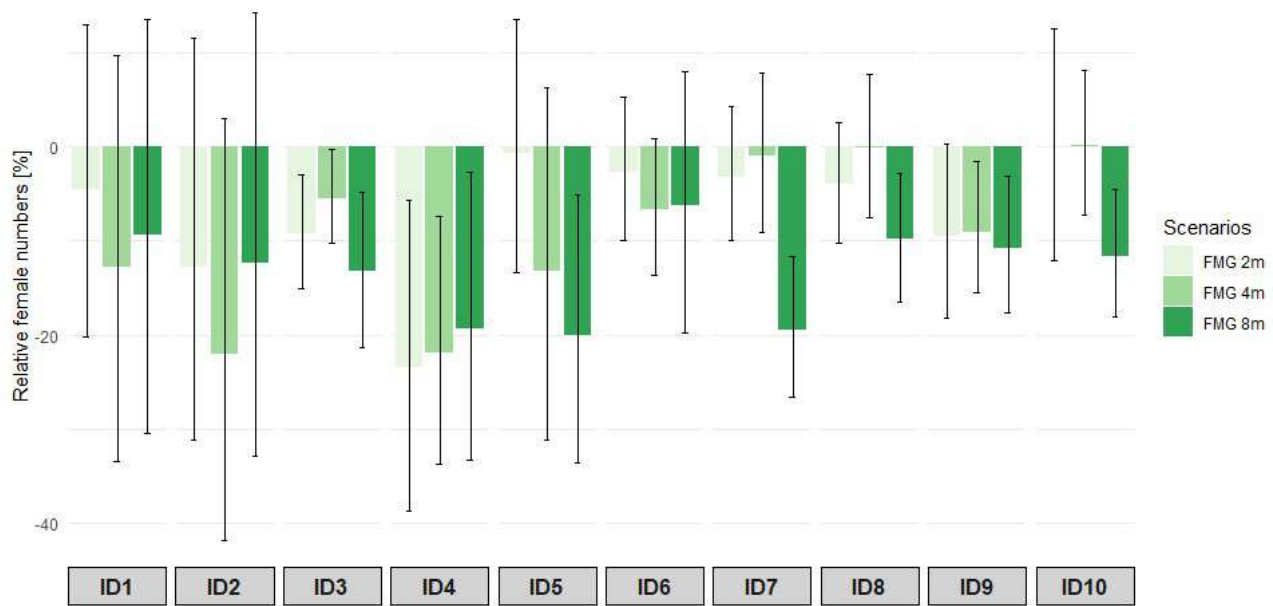


Figure 6.5 Grassy field margins scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

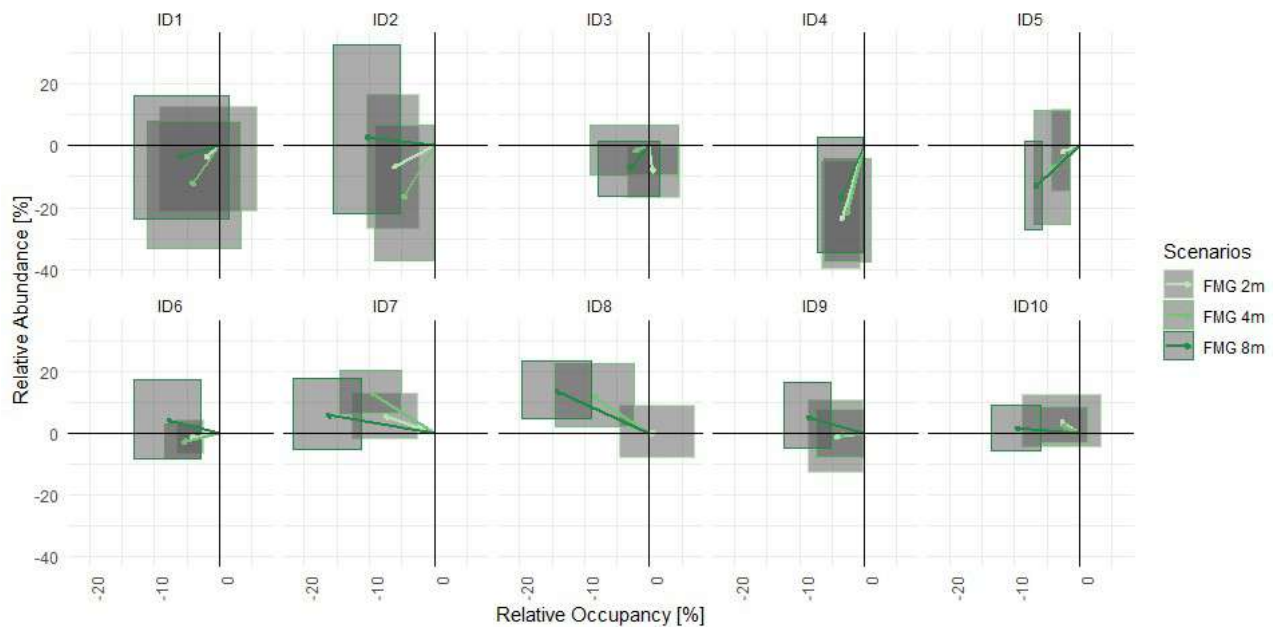


Figure 6.6 Grassy field margins with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.2.3 Mixed field margins

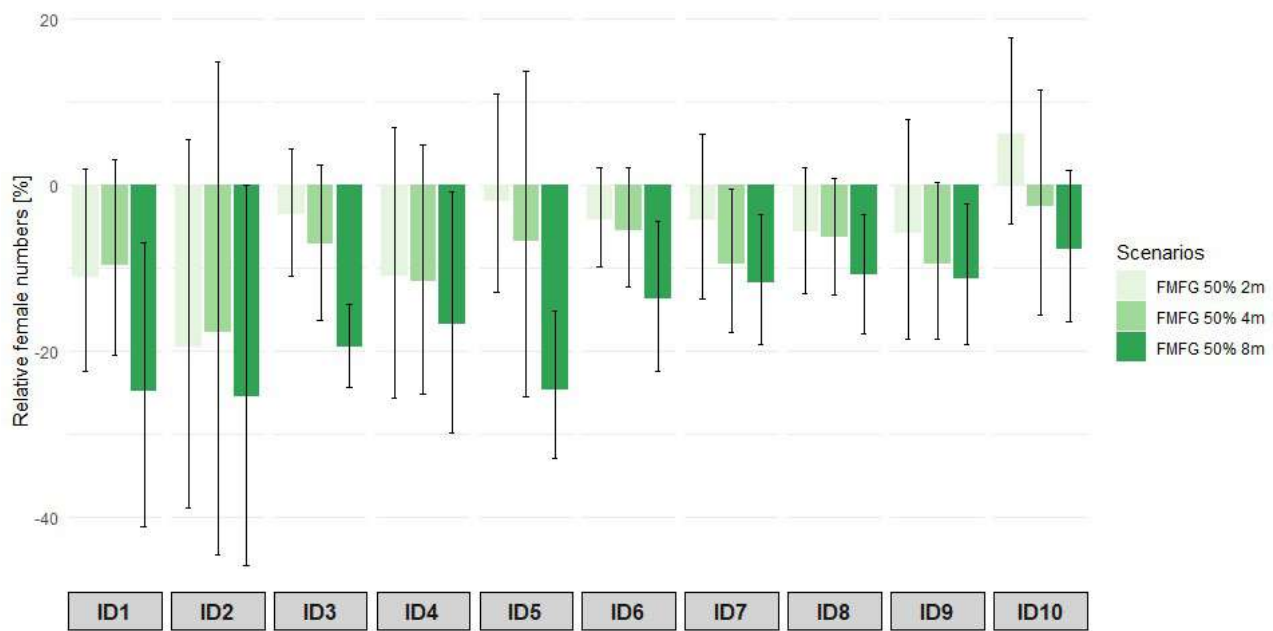


Figure 6.7 Mixed field margins scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

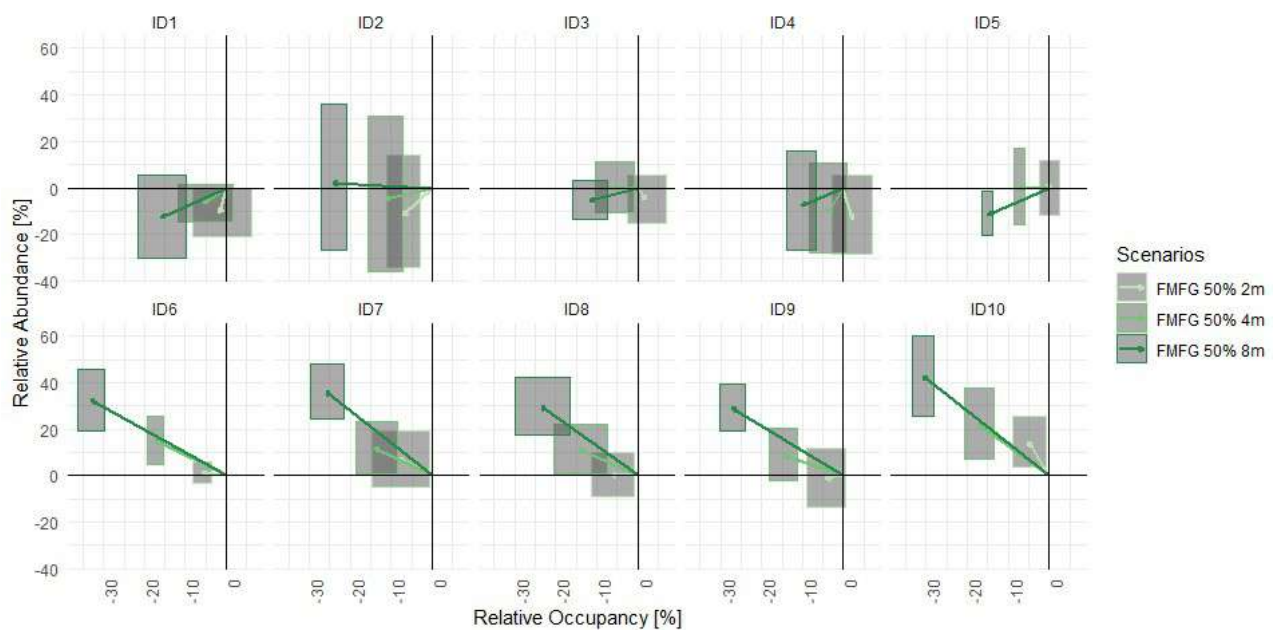


Figure 6.8 Mixed field margins with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.2.4 Flower, grassy and mixed field margins

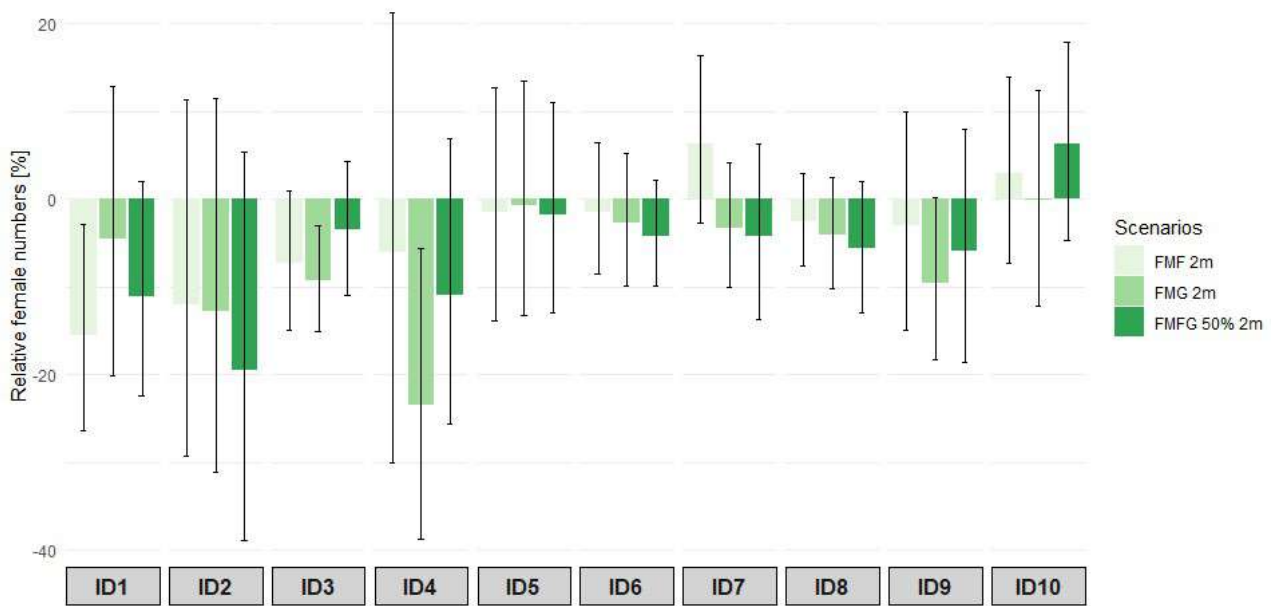


Figure 6.9 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

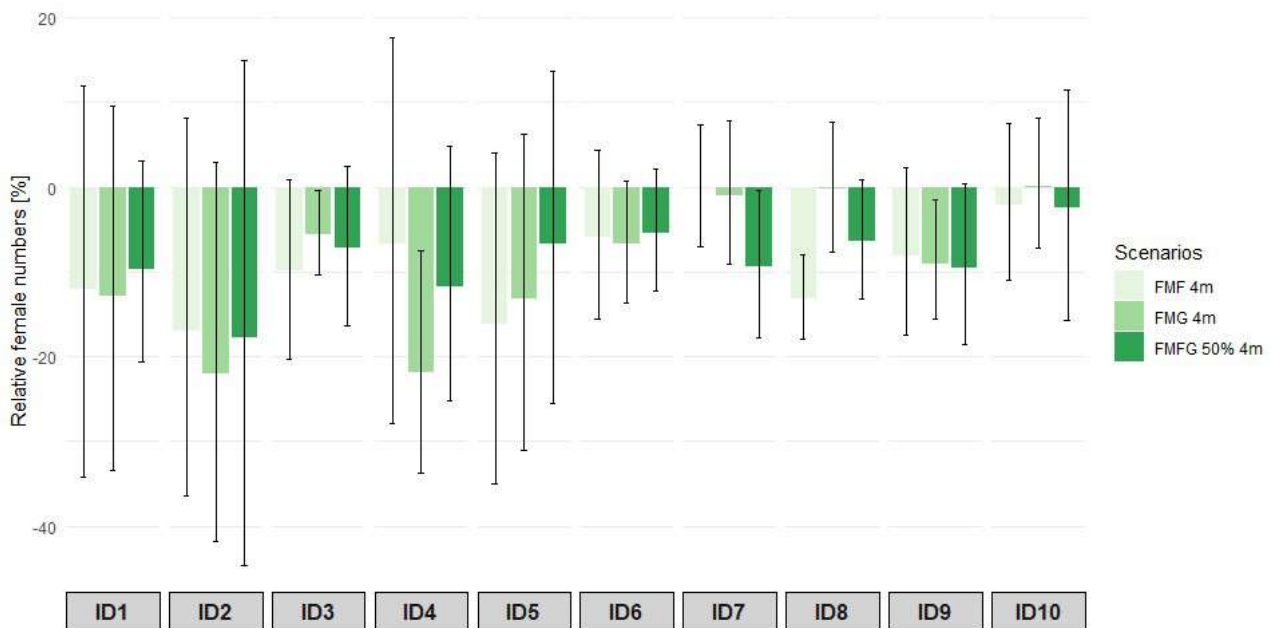


Figure 6.10 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.



Figure 6.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

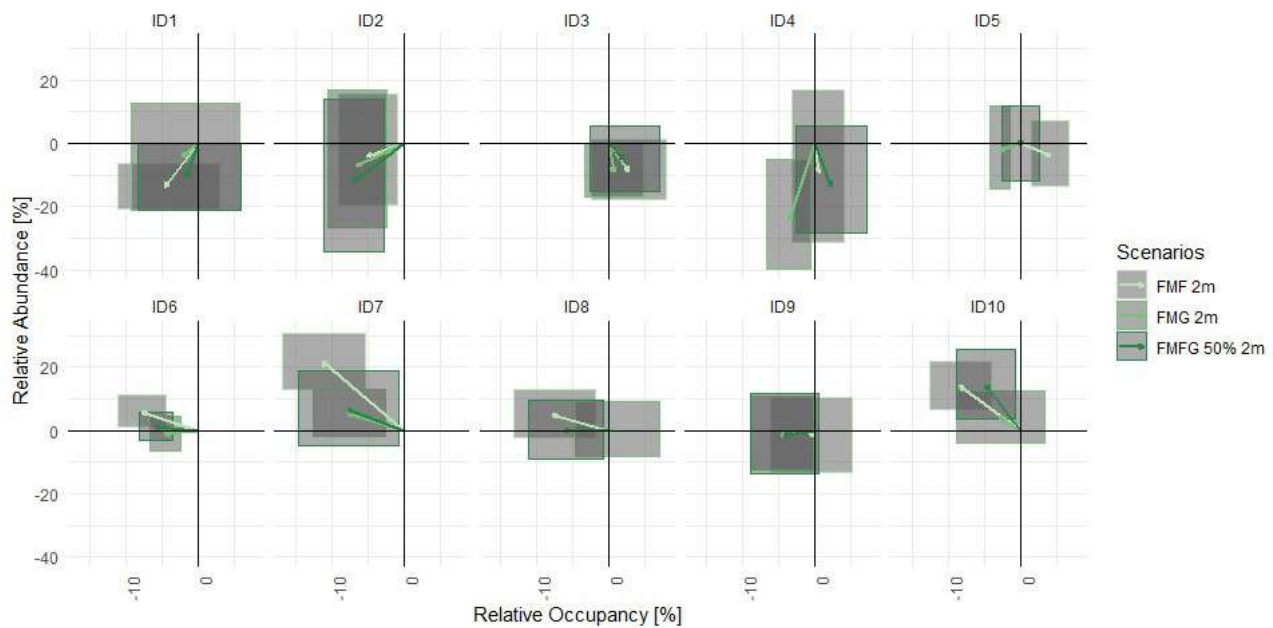


Figure 6.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

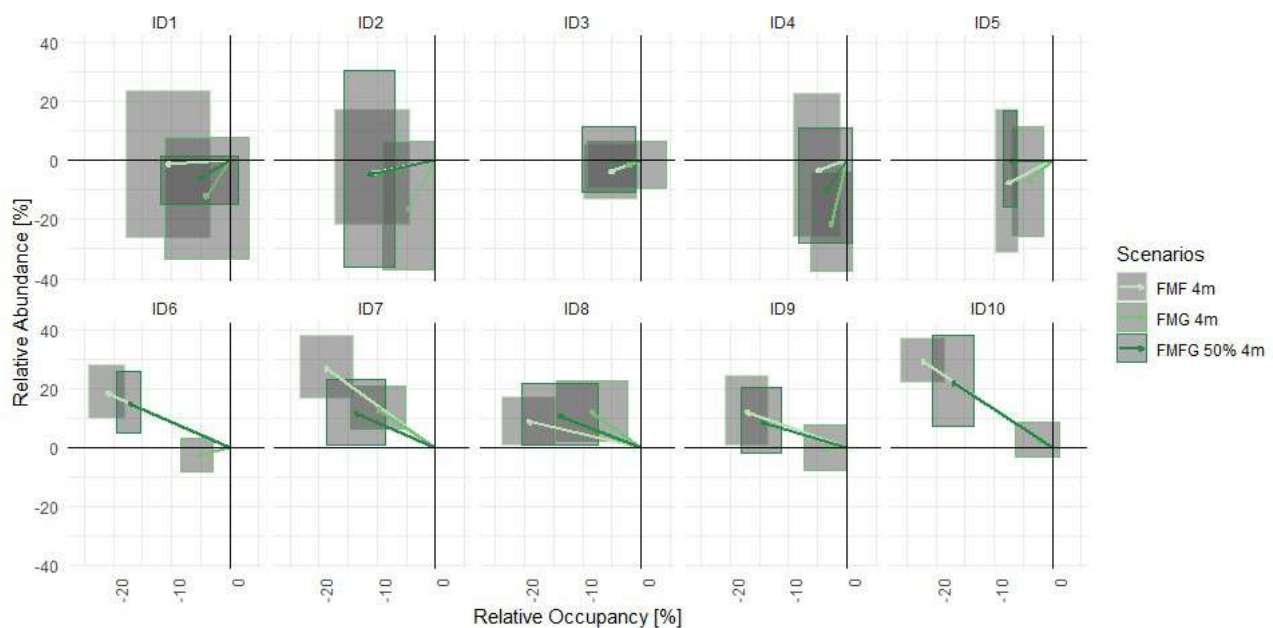


Figure 6.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes..

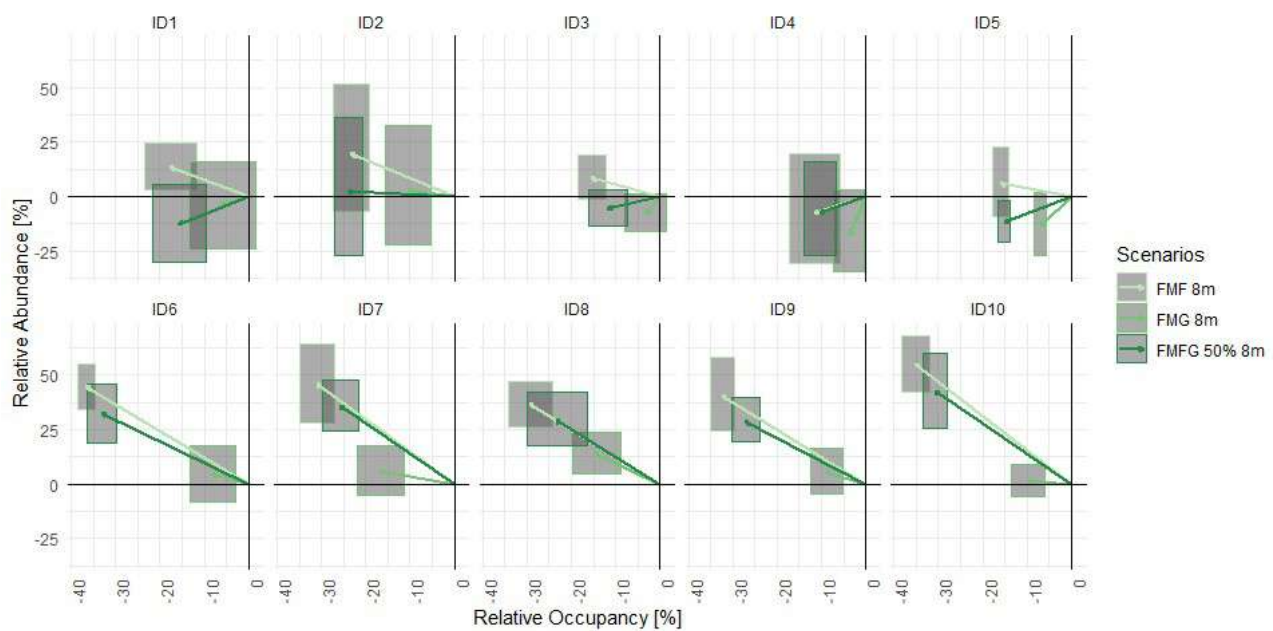


Figure 6.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.2.5 Setaside



Figure 6.15 Setaside scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

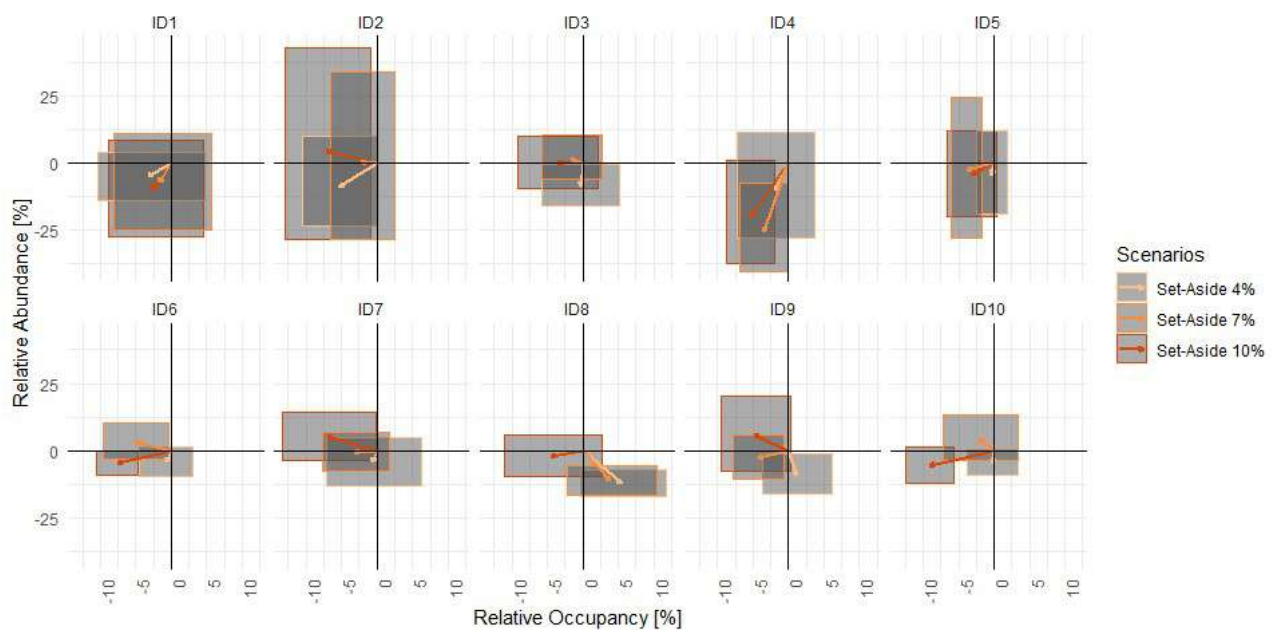


Figure 6.16 Setaside scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.2.6 Legume

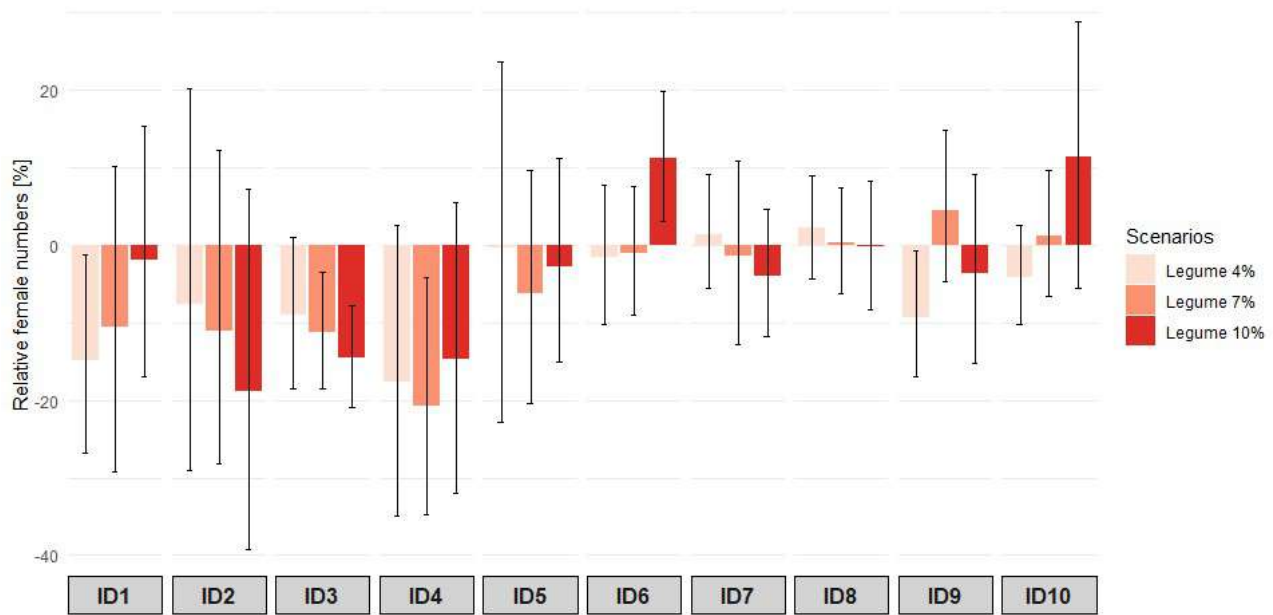


Figure 6.17 Legume scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

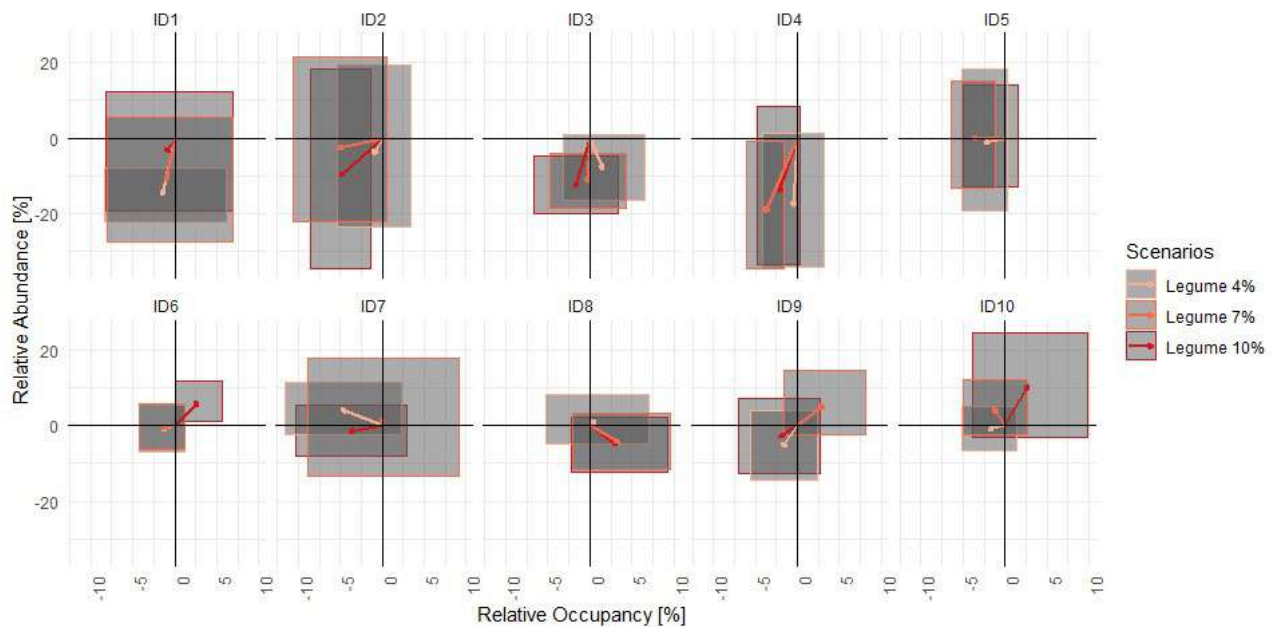


Figure 6.18 Legume scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.2.7 Biopesticides

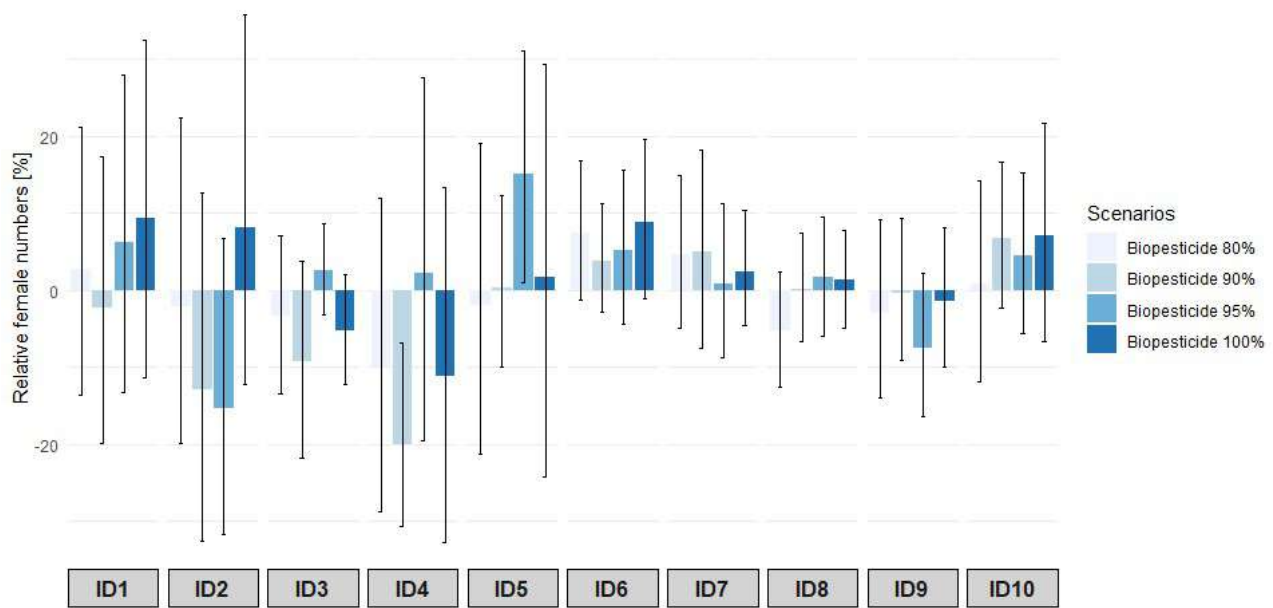


Figure 6.19 Biopesticide scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Germany.

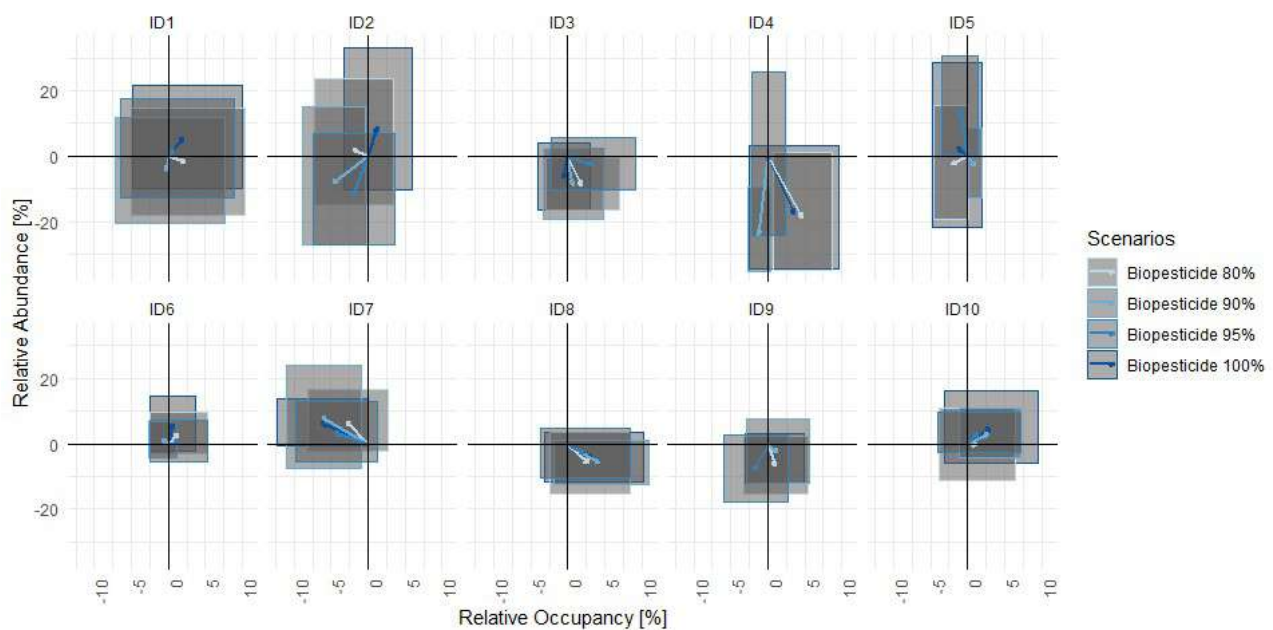


Figure 6.20 Biopesticide scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Germany at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3 Denmark

6.3.1 Crop diversification

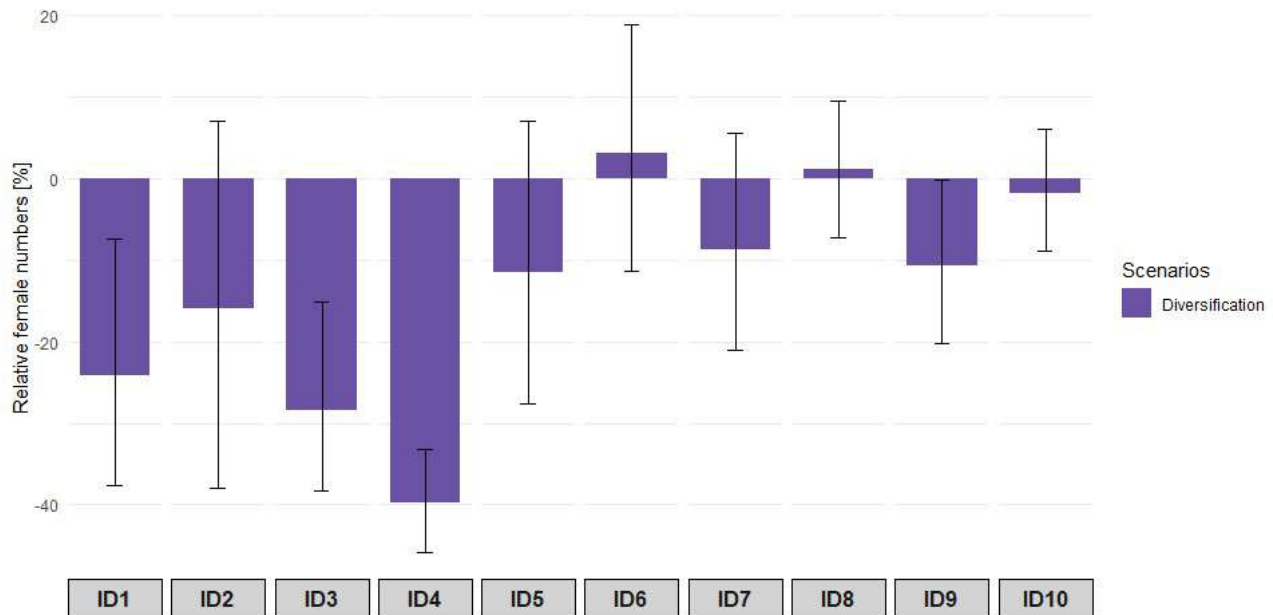


Figure 6.21 Diversification scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

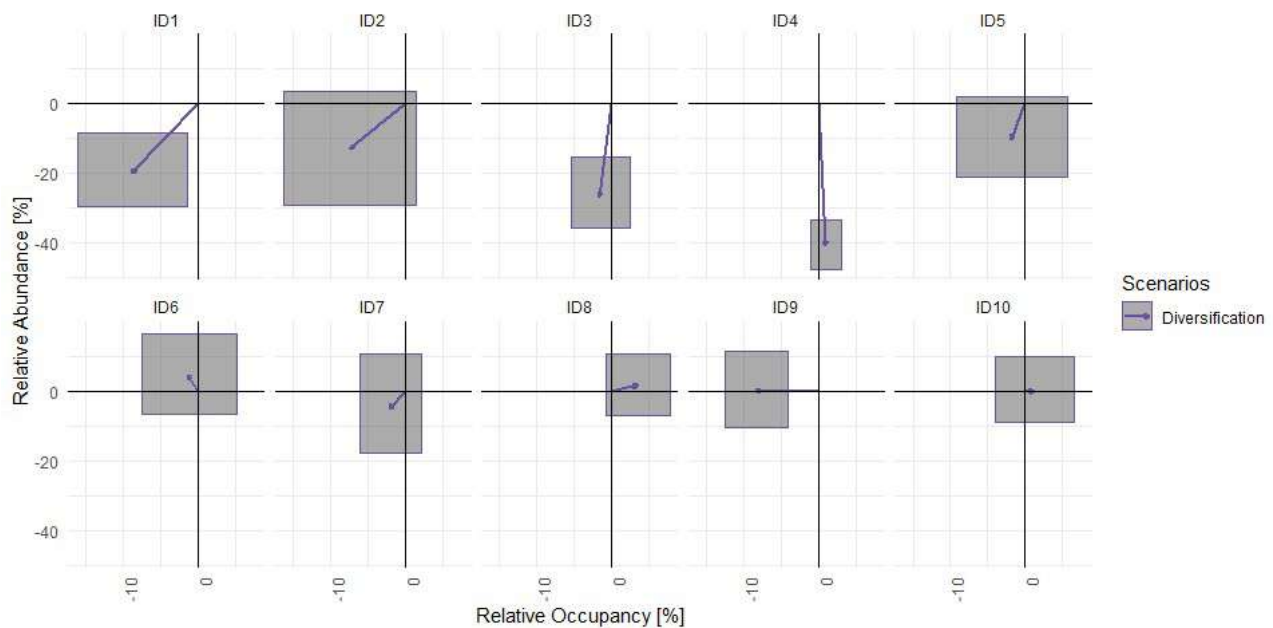


Figure 6.22 Diversification scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.2 Flower field margins

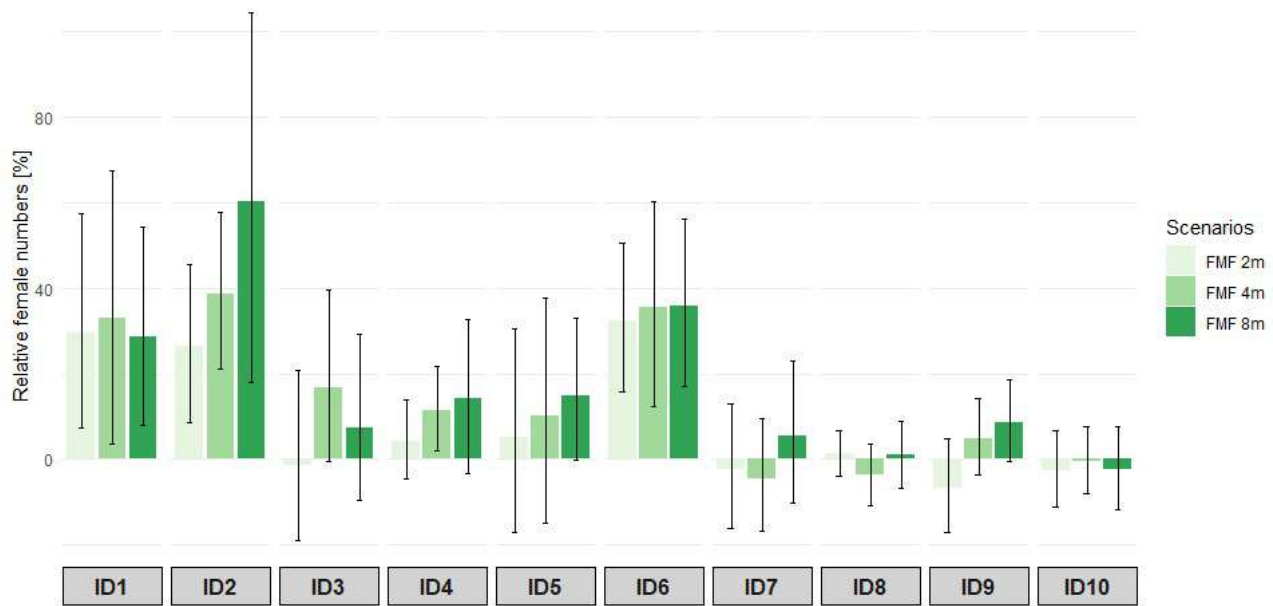


Figure 6.23 Flower field margins scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

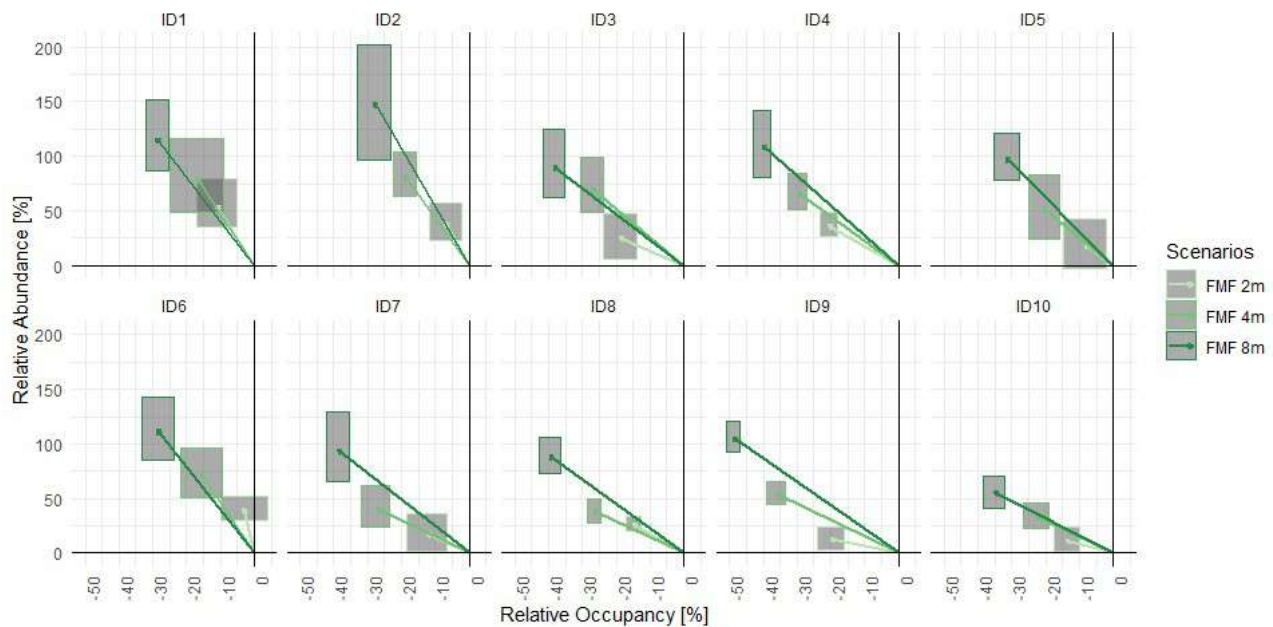


Figure 6.24 Flower field margins with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.3 Grassy field margins

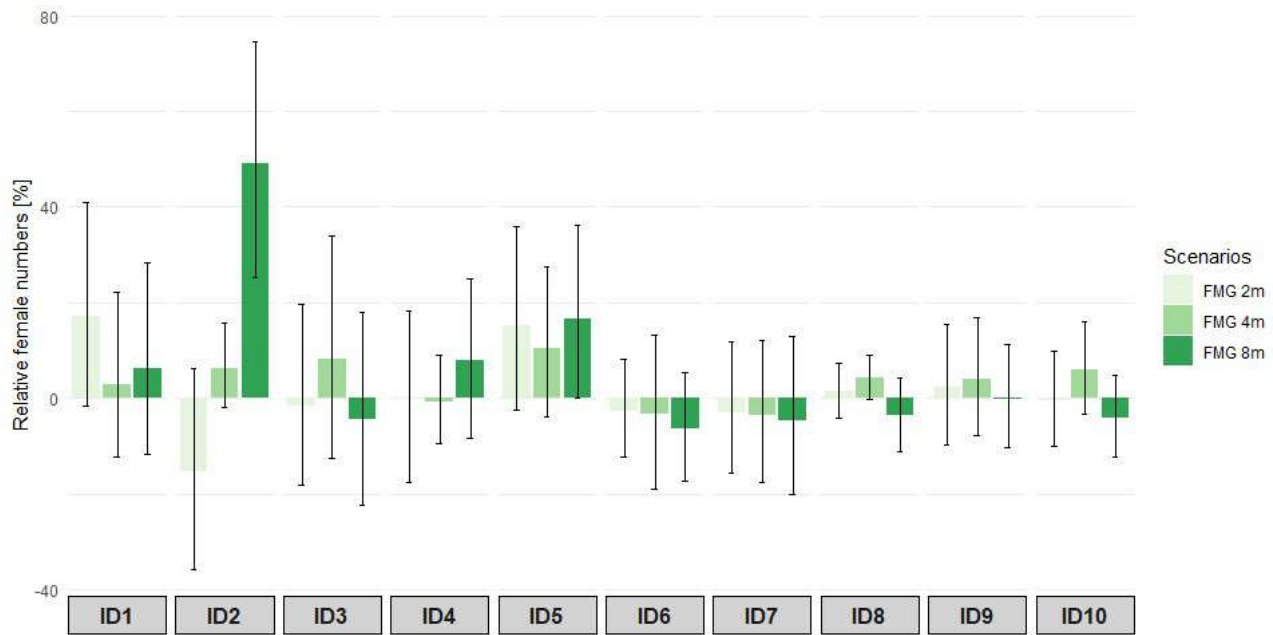


Figure 6.25 Grassy field margins scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

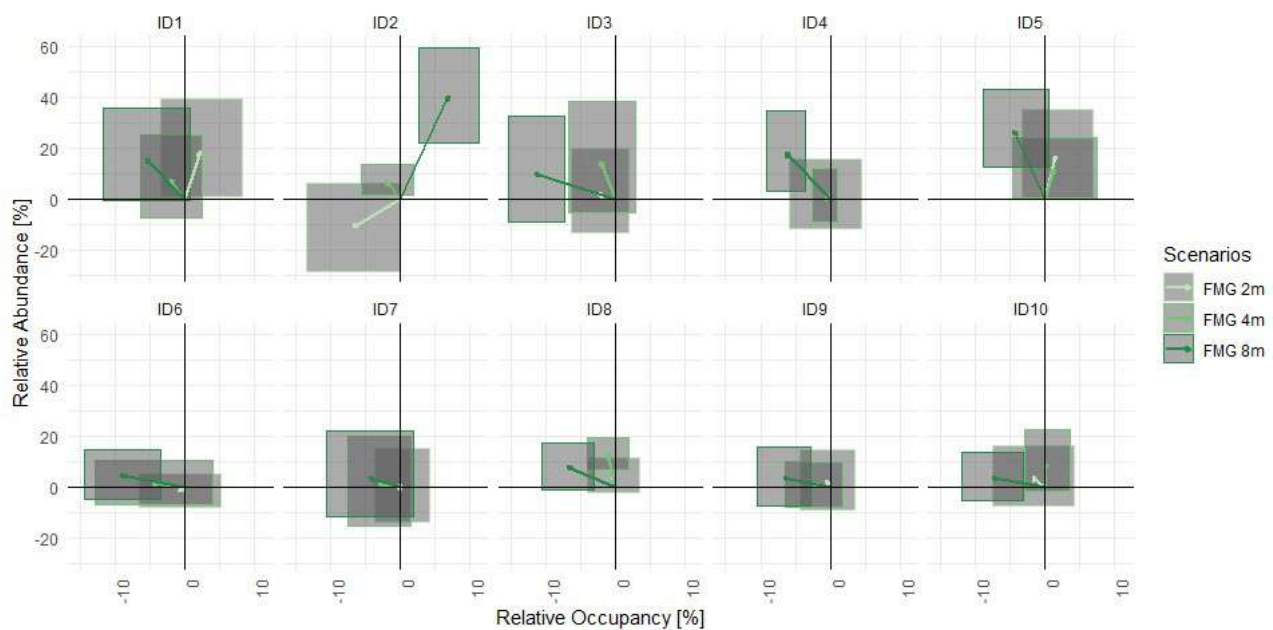


Figure 6.26 Grassy field margins with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.4 Mixed field margins

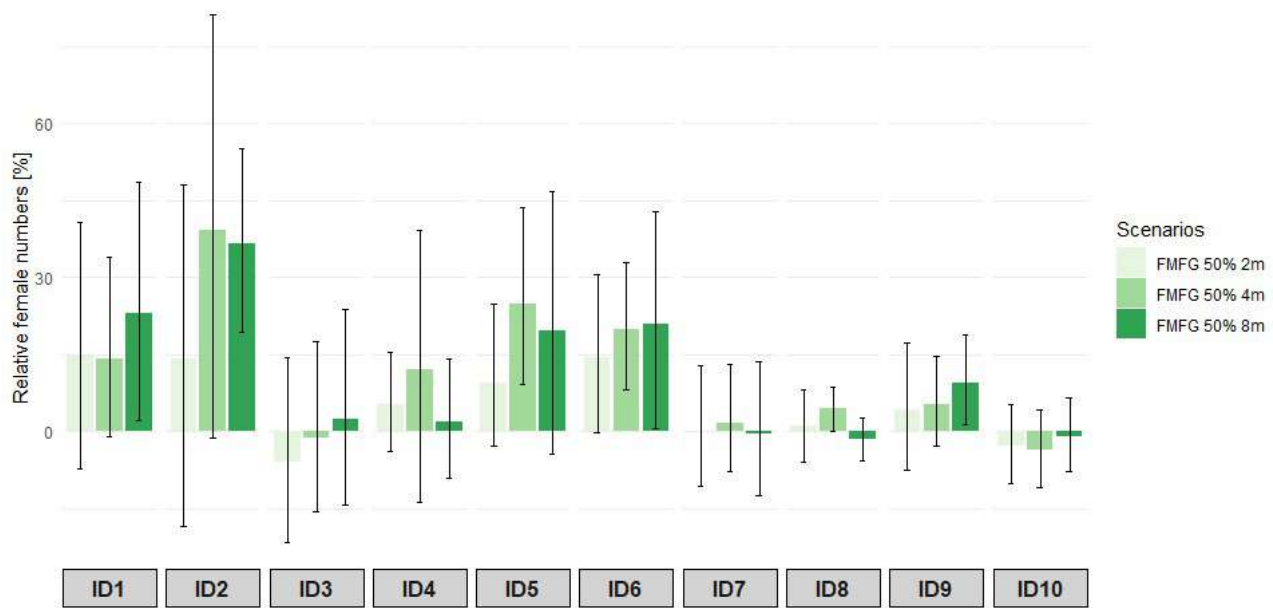


Figure 6.27 Mixed field margins scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

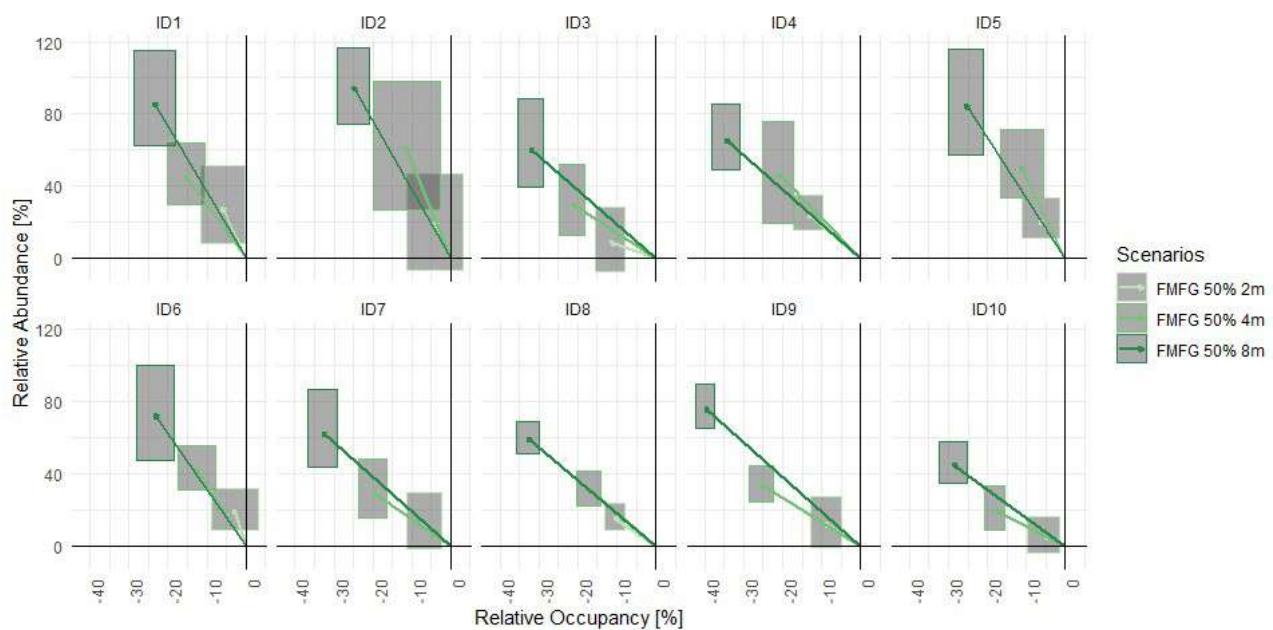


Figure 6.28 Mixed field margins with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.5 Flower, grassy and mixed field margins

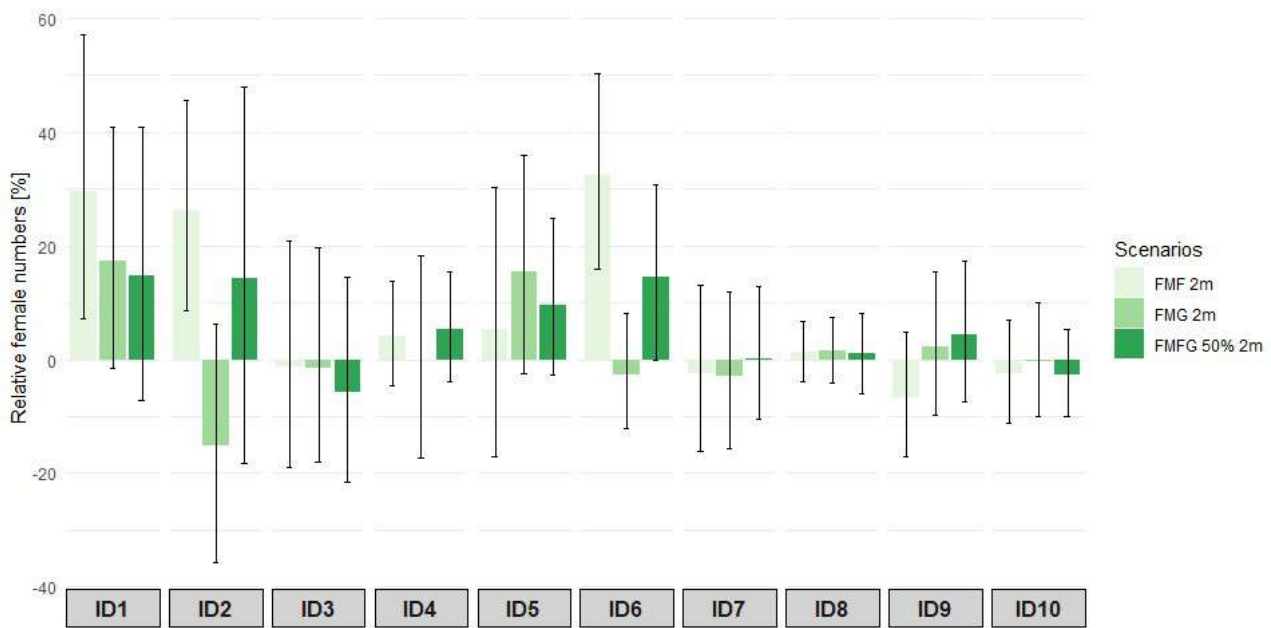


Figure 6.29 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

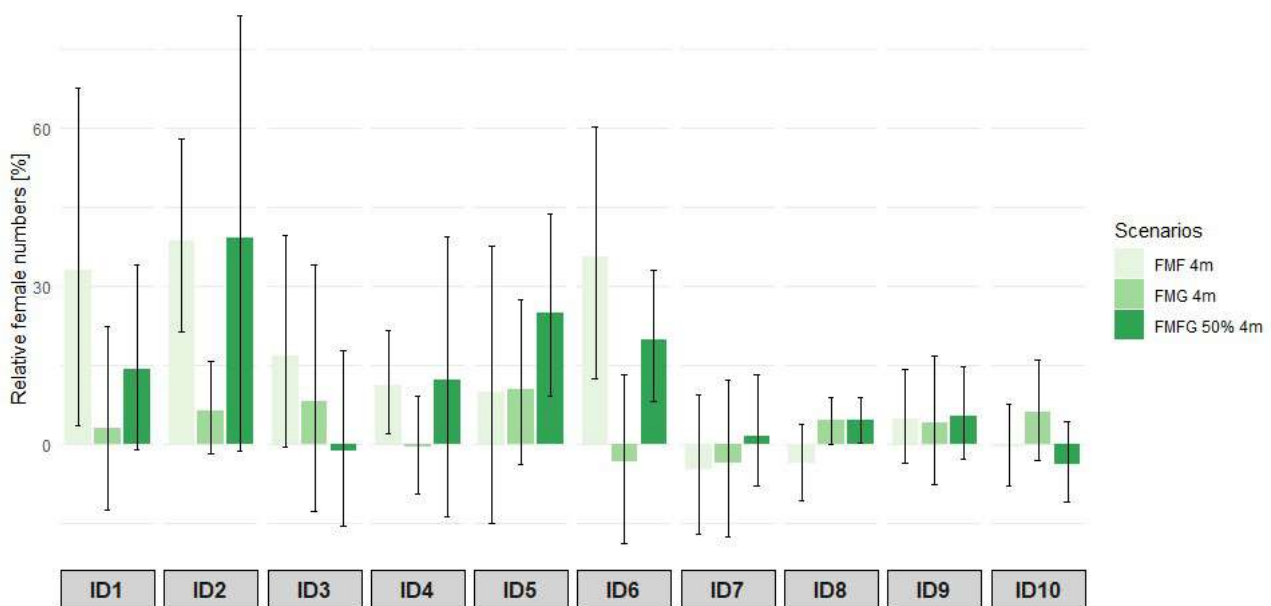


Figure 6.30 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

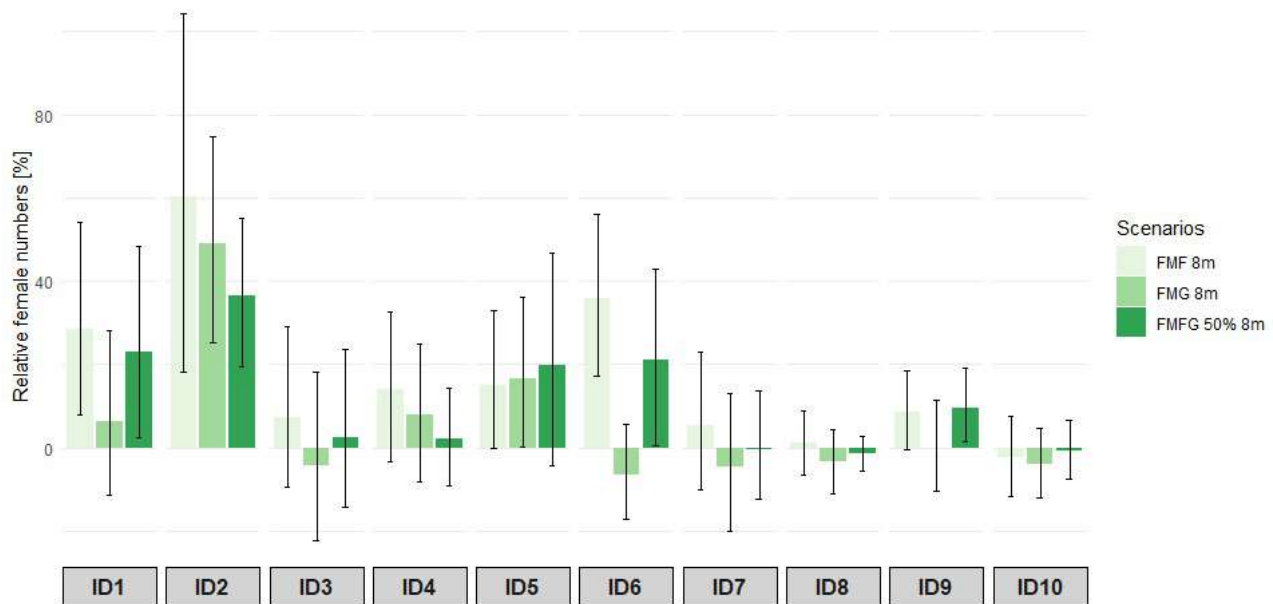


Figure 6.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

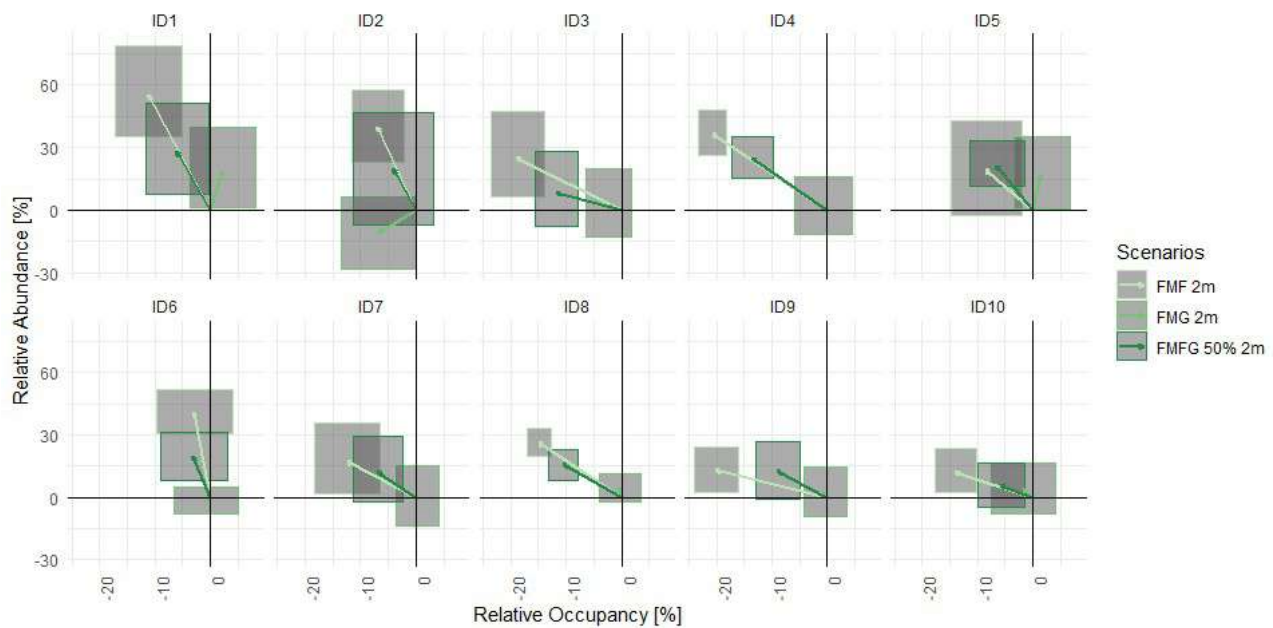


Figure 6.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

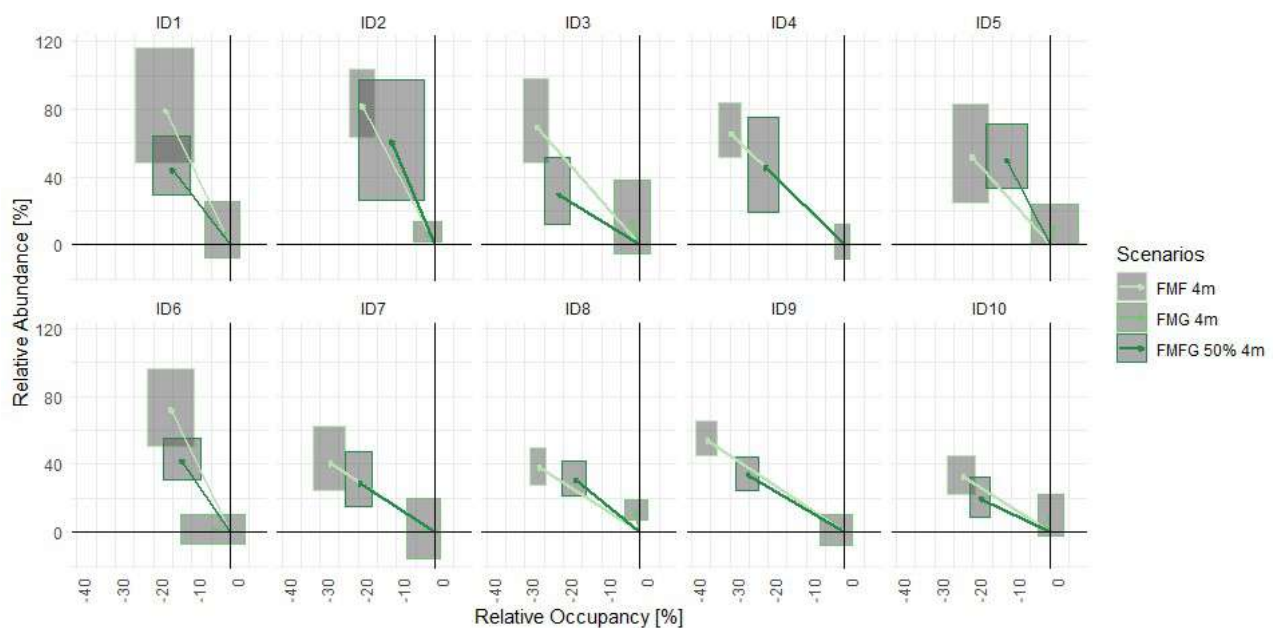


Figure 6.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes..

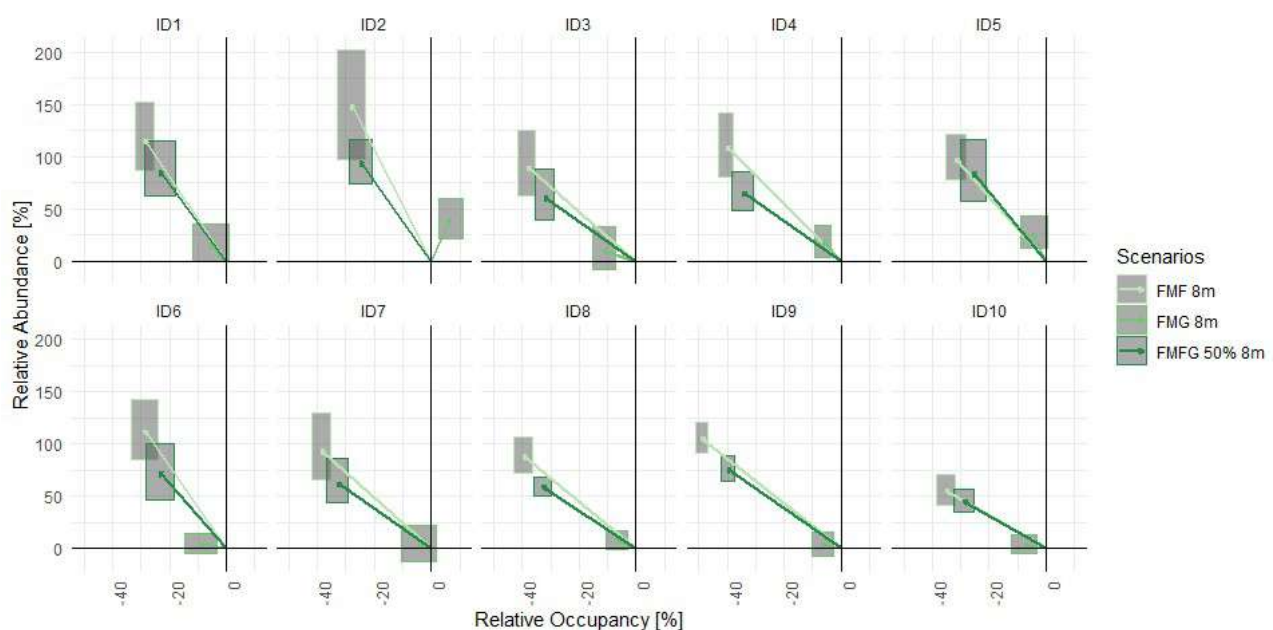


Figure 6.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.6 Setaside

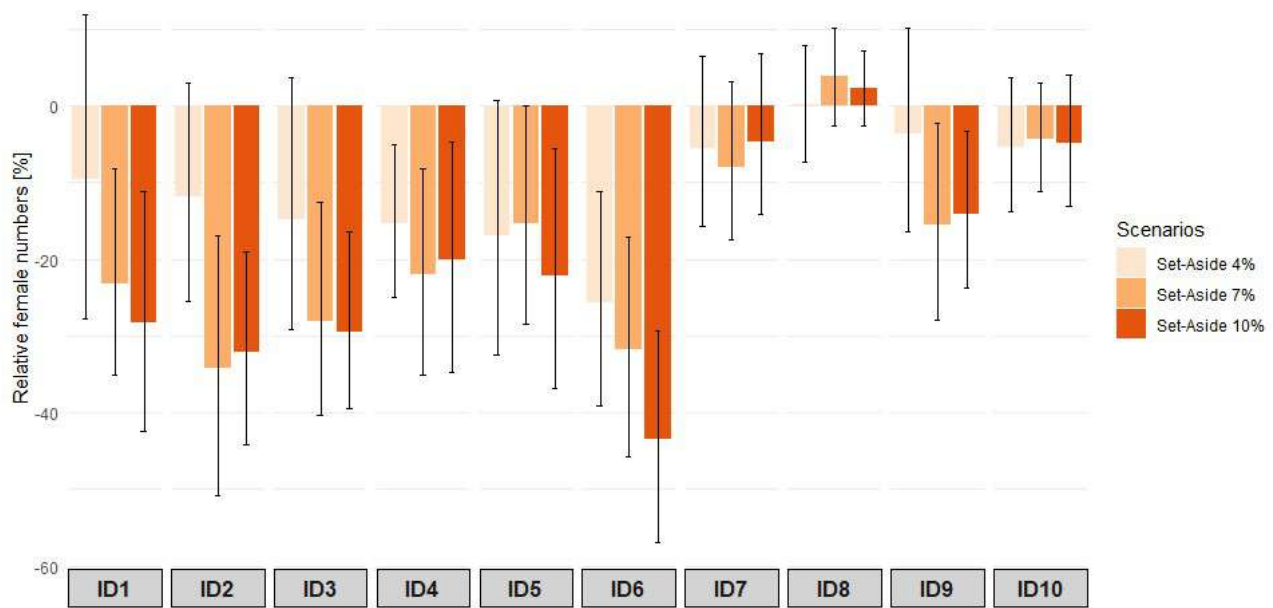


Figure 6.35 Setaside scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

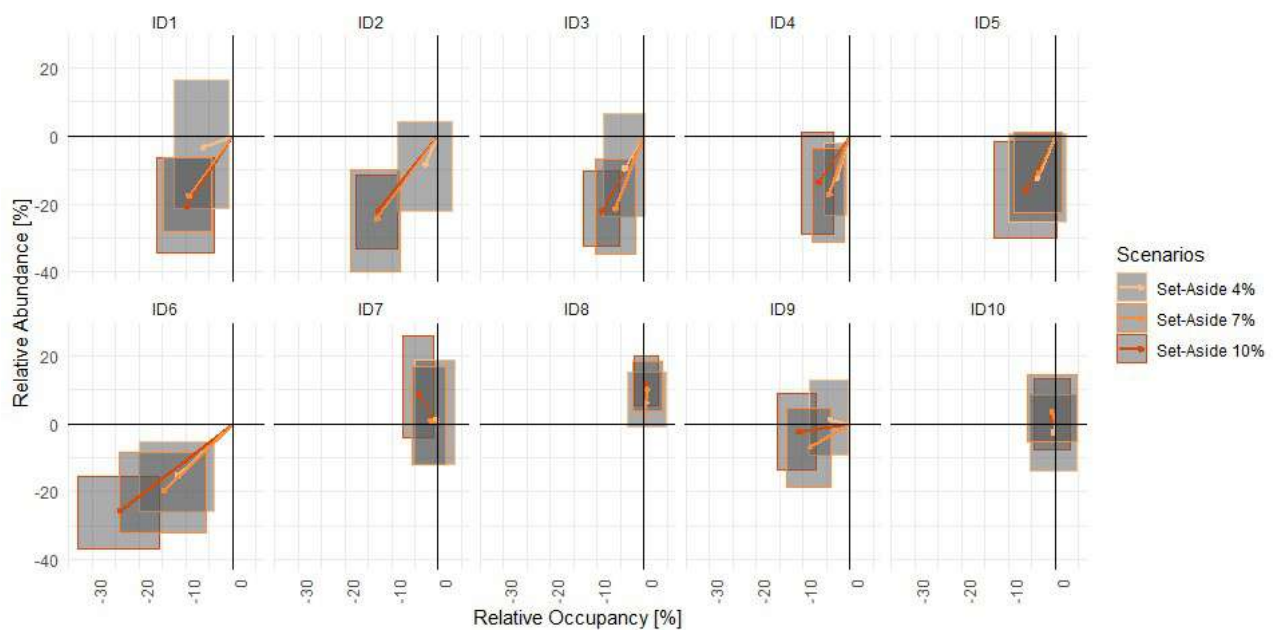


Figure 6.36 Setaside scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.7 Legume

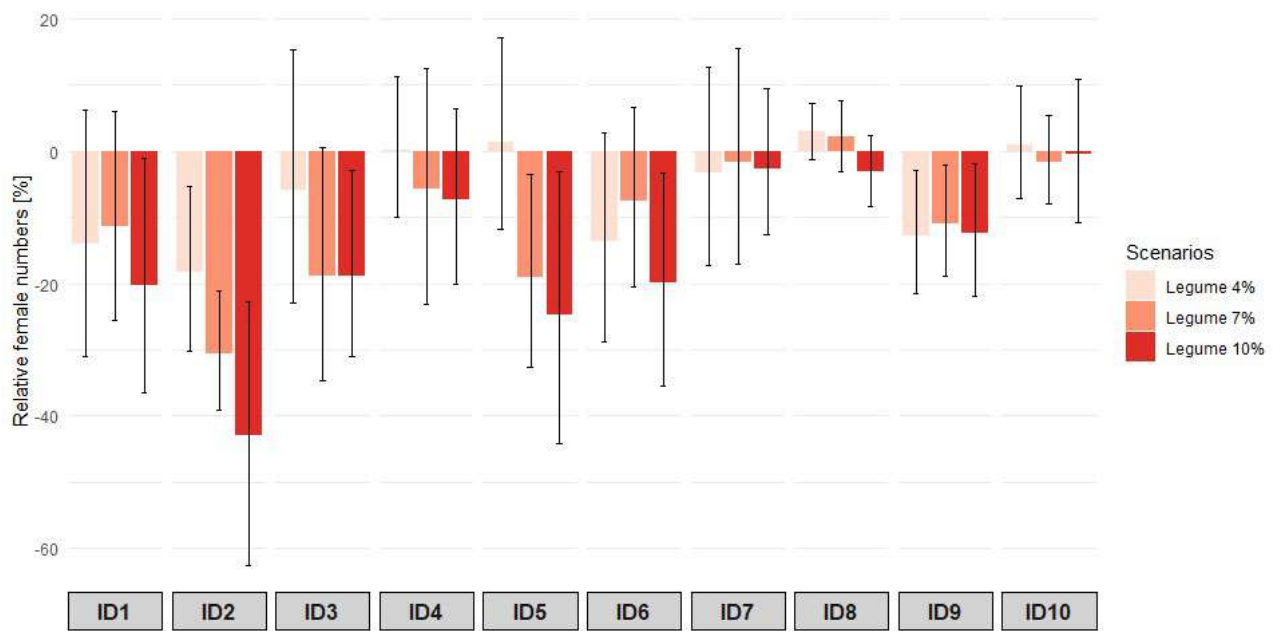


Figure 6.37 Legume scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

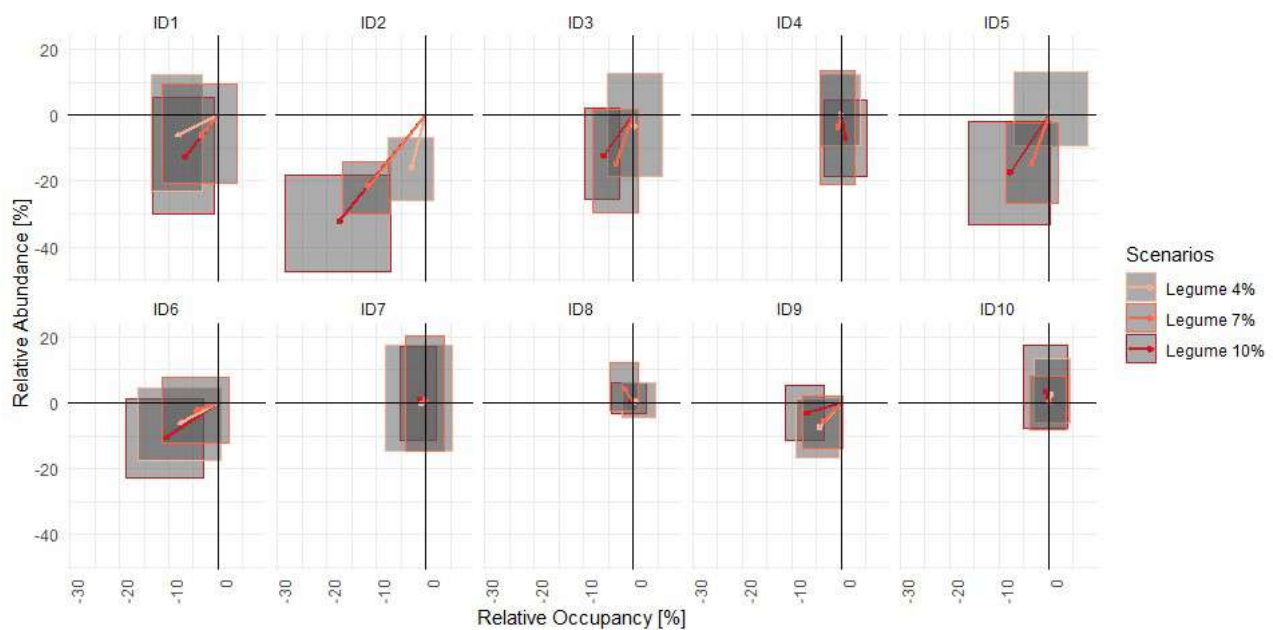


Figure 6.38 Legume scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.3.8 Biopesticides

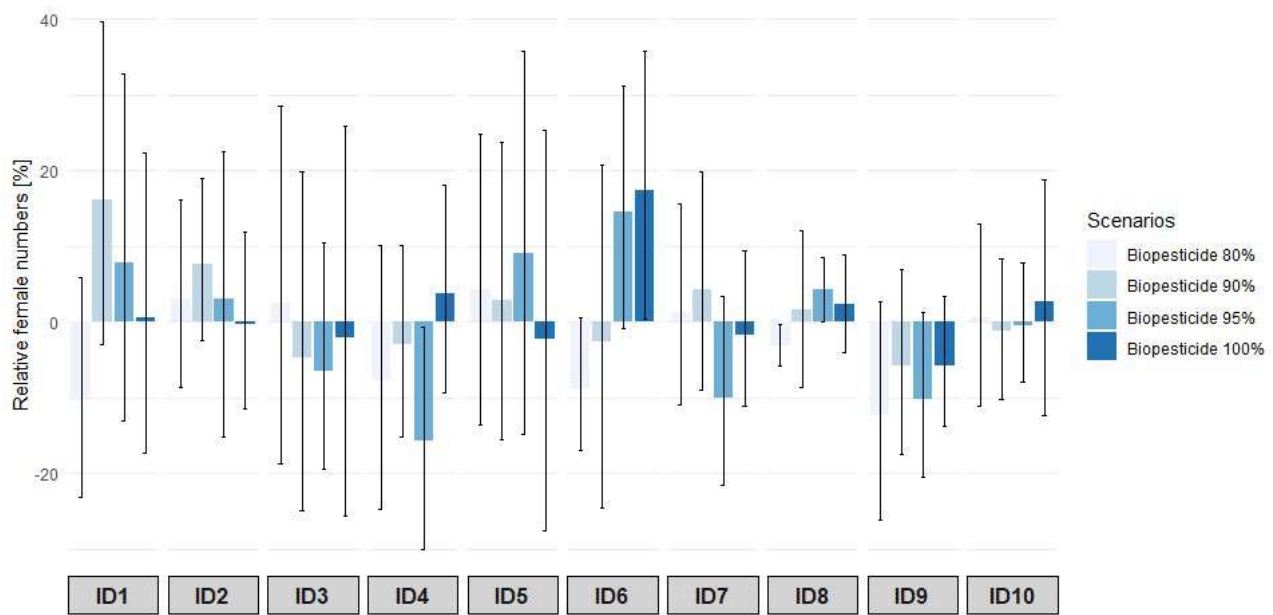


Figure 6.39 Biopesticide scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

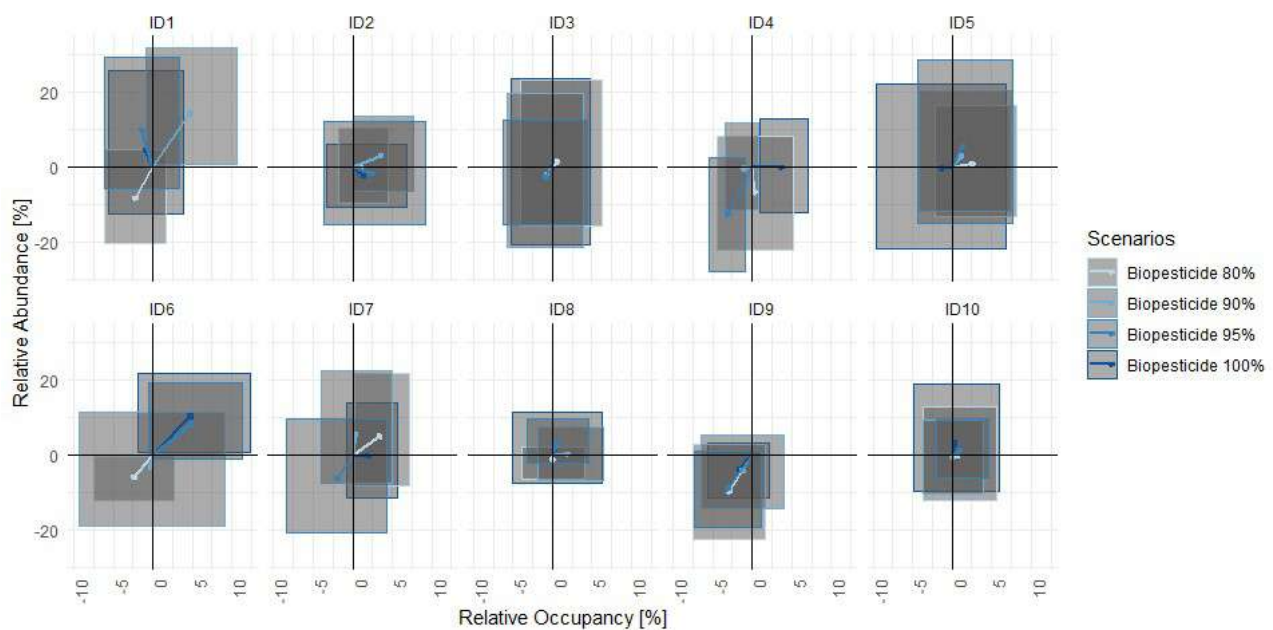


Figure 6.40 Biopesticide scenario with relative change in occupancy and abundance of female Ladybird compared to baseline $P(0,0)$ for each landscape in Denmark at a 50m resolution. Grey areas indicate standard deviation along both axes.

6.4 Combined landscapes

6.4.1 Crop diversification

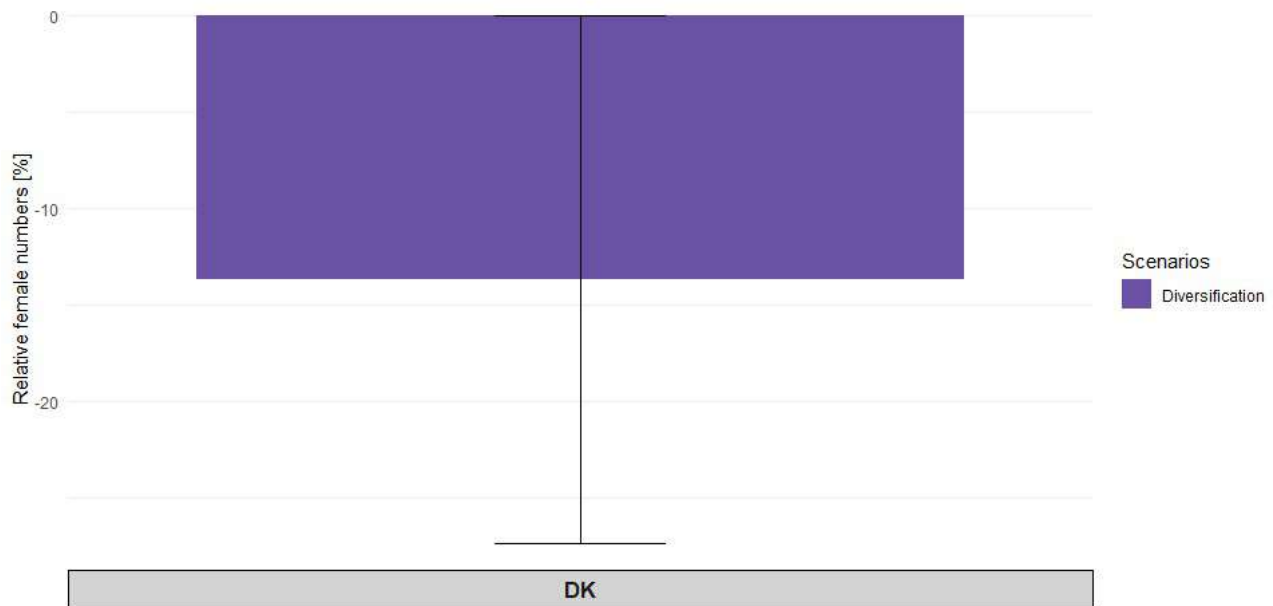


Figure 6.41 Diversification scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.2 Flower field margins

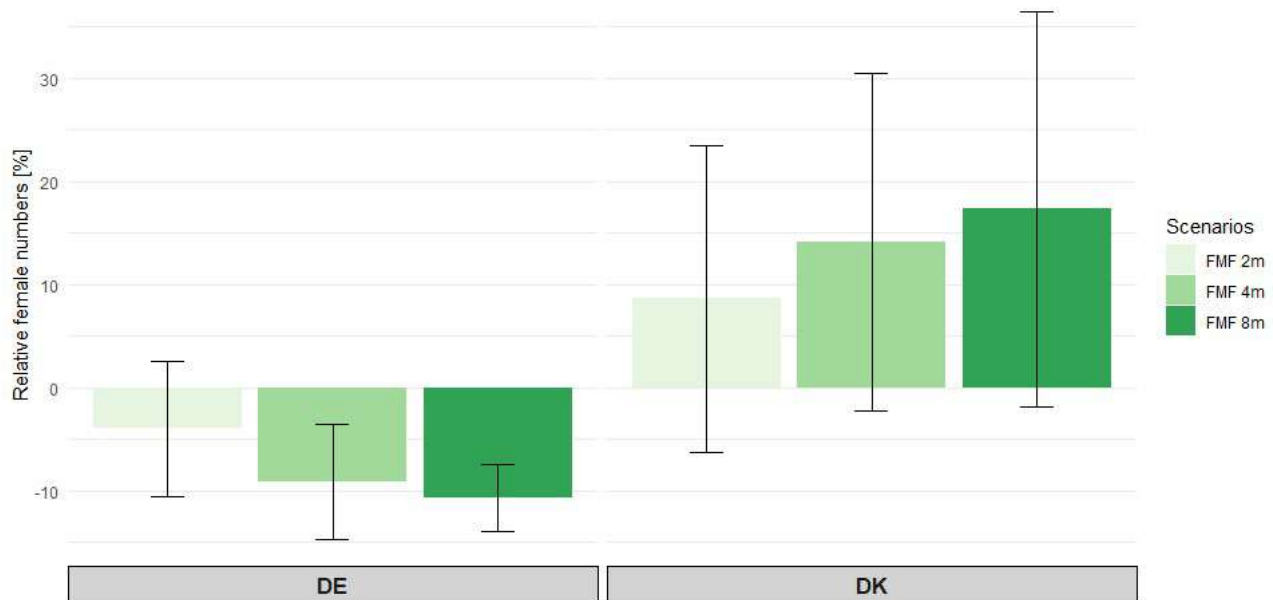


Figure 6.42 Flower field margins with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.3 Grassy field margins

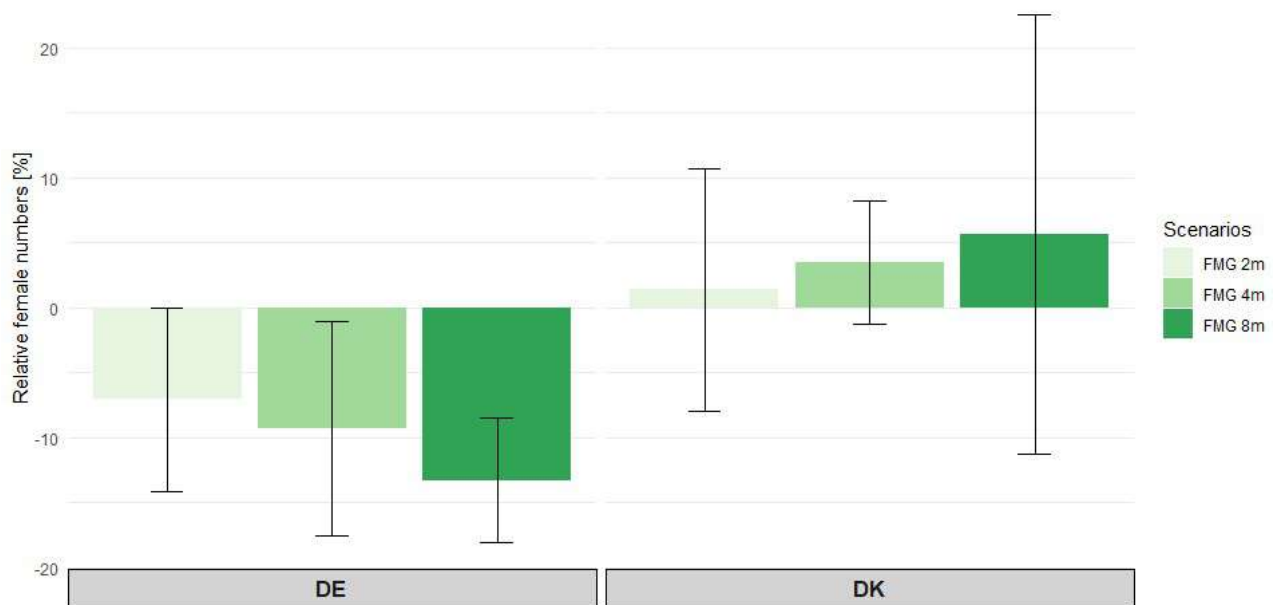


Figure 6.43 Grassy field margins with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.4 Mixed field margins

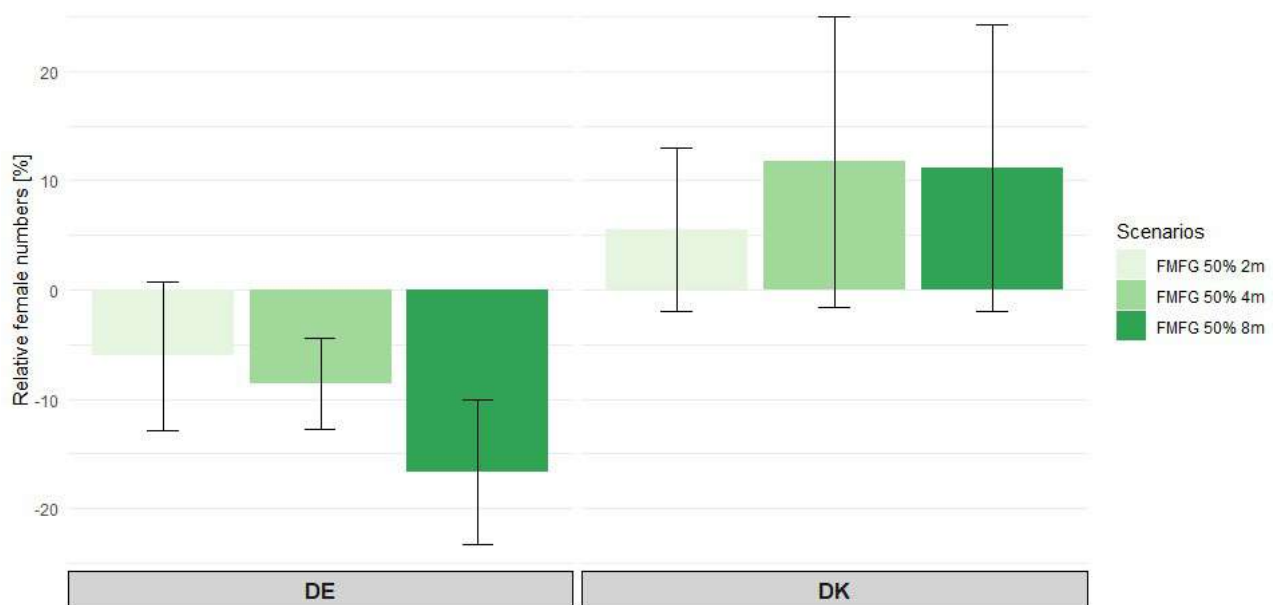


Figure 6.44 Mixed field margins with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.5 Flower, grassy and mixed margins

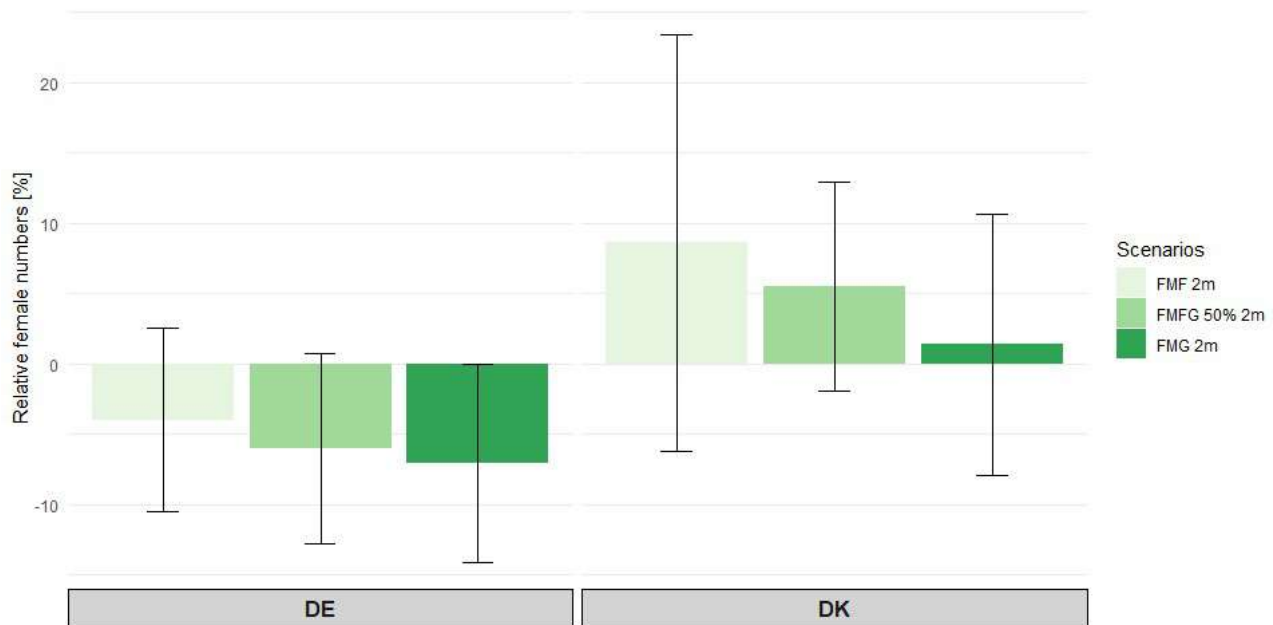


Figure 6.45 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

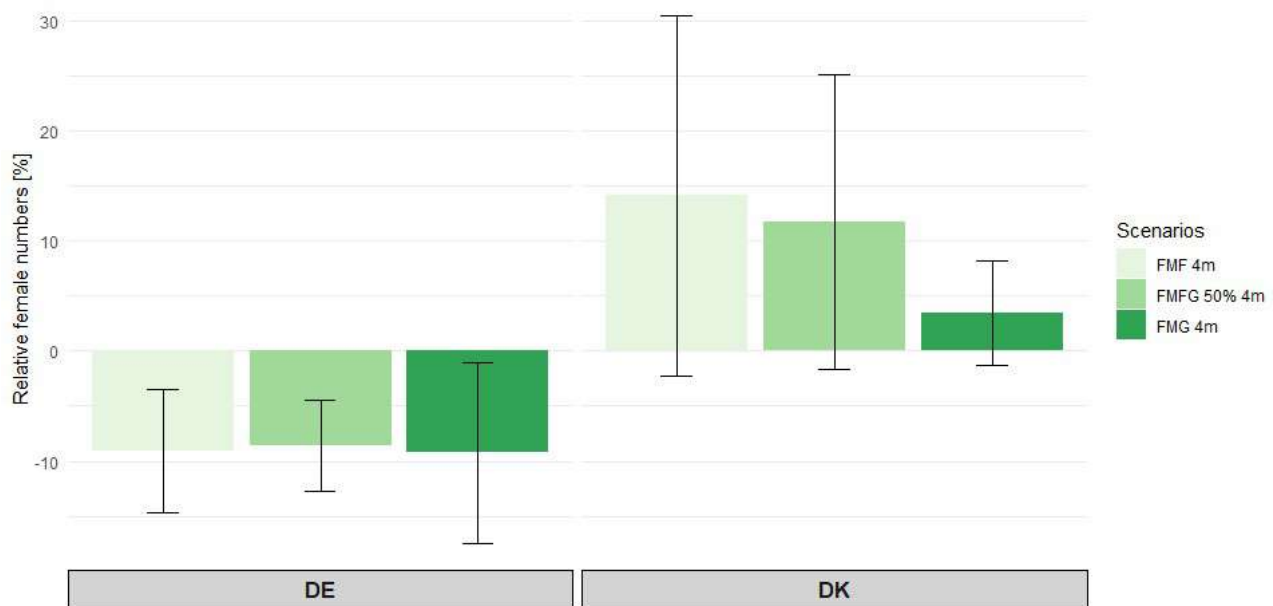


Figure 6.46 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

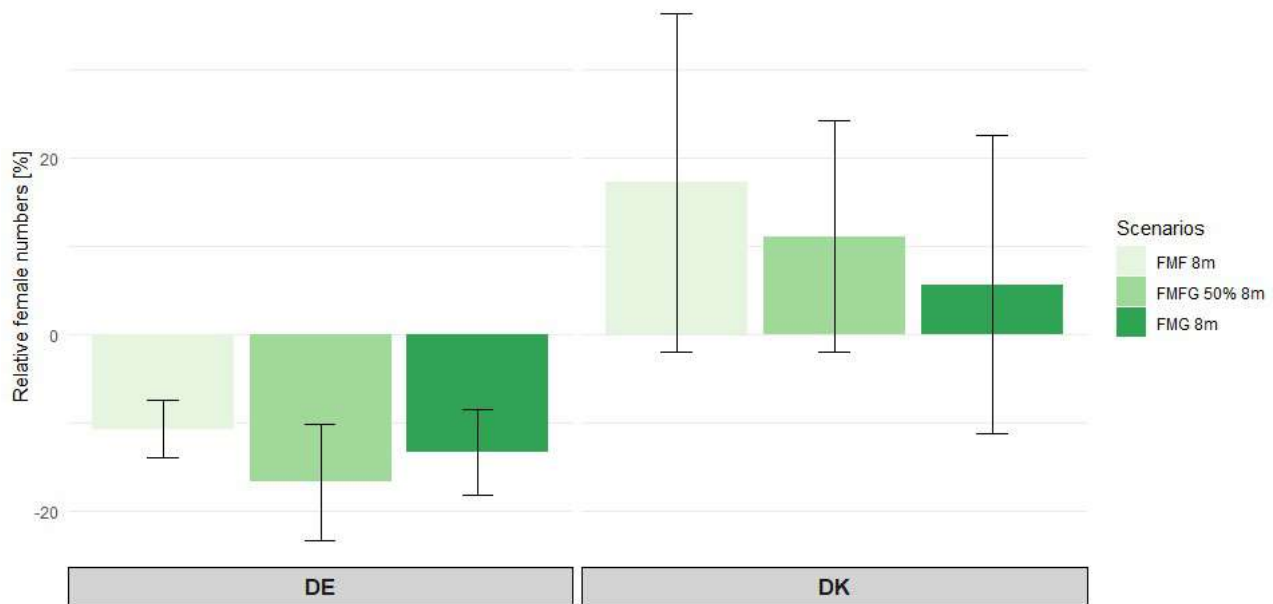


Figure 6.47 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.6 Setaside

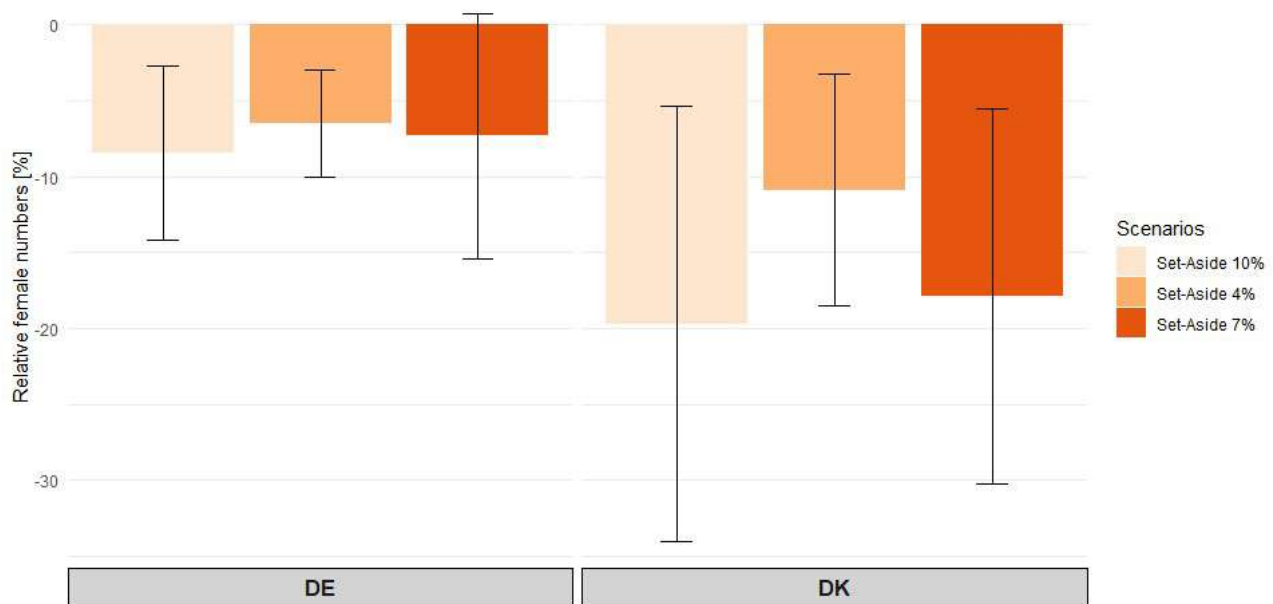


Figure 6.48 Setaside scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.7 Legume

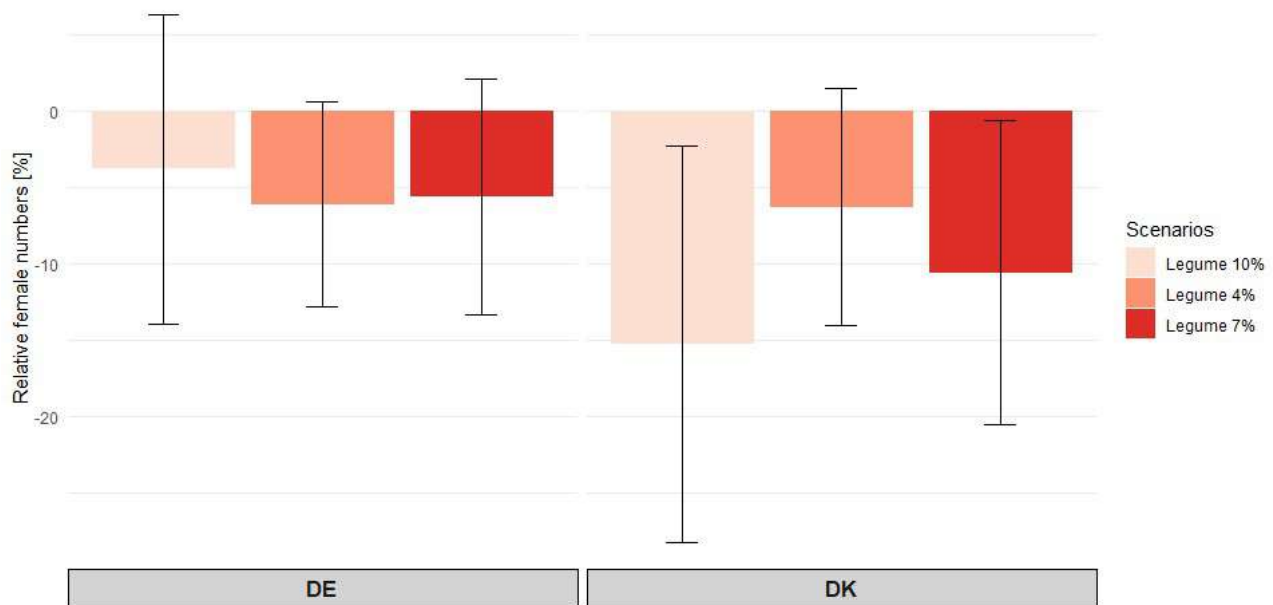


Figure 6.49 Legume scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.8 Biopesticides

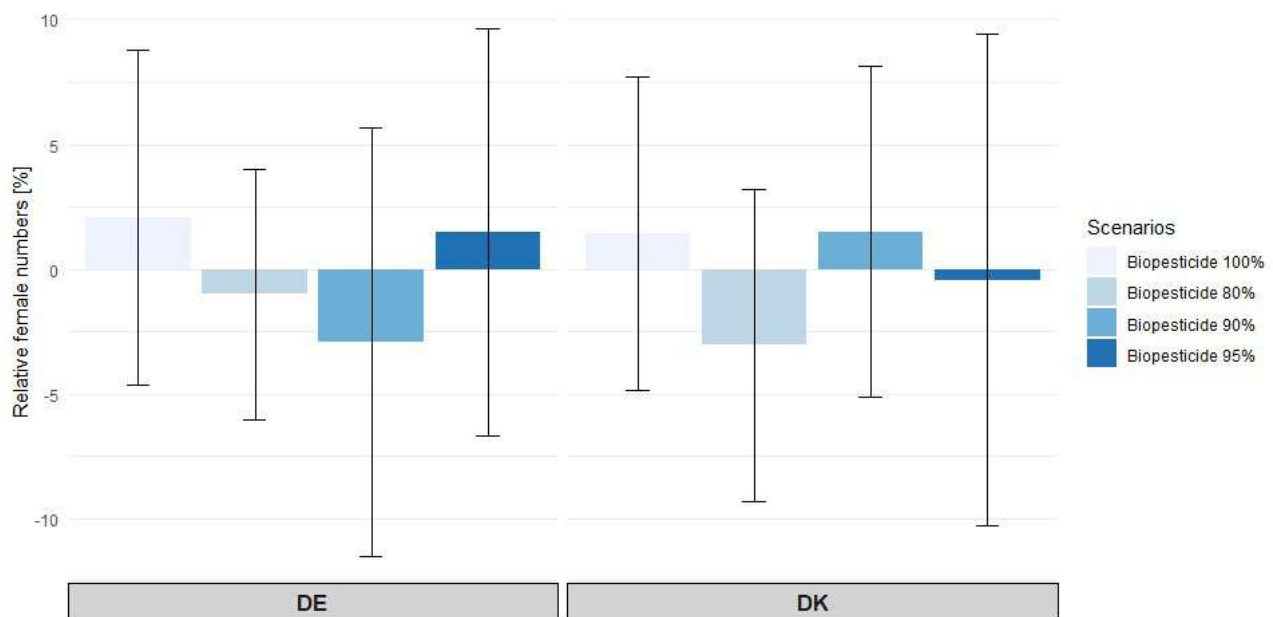


Figure 6.50 Biopesticide scenario with relative change in the number of female Ladybird compared to baseline and standard deviation presented by error bars for each simulated country.

6.4.9 Table: Country level overview of scenario effects

Table 6.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for Ladybird. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DK	DE
Diversification	-14% (SD 14%)	NA
FMF 2m	9% (SD 15%)	-4% (SD 7%)
FMF 4m	14% (SD 16%)	-9% (SD 6%)
FMF 8m	17% (SD 19%)	-11% (SD 3%)
FMG 2m	1% (SD 9%)	-7% (SD 7%)
FMG 4m	3% (SD 5%)	-9% (SD 8%)
FMG 8m	6% (SD 17%)	-13% (SD 5%)
FMFG 50% 2m	6% (SD 7%)	-6% (SD 7%)
FMFG 50% 4m	12% (SD 13%)	-9% (SD 4%)
FMFG 50% 8m	11% (SD 13%)	-17% (SD 7%)
Set-Aside 4%	-11% (SD 8%)	-7% (SD 4%)
Set-Aside 7%	-18% (SD 12%)	-7% (SD 8%)
Set-Aside 10%	-20% (SD 14%)	-8% (SD 6%)
Legume 4%	-6% (SD 8%)	-6% (SD 7%)
Legume 7%	-11% (SD 10%)	-6% (SD 8%)
Legume 10%	-15% (SD 13%)	-4% (SD 10%)
Biopesticide 80%	-3% (SD 6%)	-1% (SD 5%)
Biopesticide 90%	2% (SD 7%)	-3% (SD 9%)
Biopesticide 95%	-0% (SD 10%)	2% (SD 8%)
Biopesticide 100%	1% (SD 6%)	2% (SD 7%)

Scenario	DK	DE
Diversification	-14% (SD 14%)	NA
FMF 2m	9% (SD 15%)	-4% (SD 7%)
FMF 4m	14% (SD 16%)	-9% (SD 6%)
FMF 8m	17% (SD 19%)	-11% (SD 3%)
FMG 2m	1% (SD 9%)	-7% (SD 7%)
FMG 4m	3% (SD 5%)	-9% (SD 8%)
FMG 8m	6% (SD 17%)	-13% (SD 5%)
FMFG 50% 2m	6% (SD 7%)	-6% (SD 7%)
FMFG 50% 4m	12% (SD 13%)	-9% (SD 4%)
FMFG 50% 8m	11% (SD 13%)	-17% (SD 7%)
Set-Aside 4%	-11% (SD 8%)	-7% (SD 4%)
Set-Aside 7%	-18% (SD 12%)	-7% (SD 8%)
Set-Aside 10%	-20% (SD 14%)	-8% (SD 6%)
Legume 4%	-6% (SD 8%)	-6% (SD 7%)
Legume 7%	-11% (SD 10%)	-6% (SD 8%)
Legume 10%	-15% (SD 13%)	-4% (SD 10%)
Biopesticide 80%	-3% (SD 6%)	-1% (SD 5%)
Biopesticide 90%	2% (SD 7%)	-3% (SD 9%)
Biopesticide 95%	-0% (SD 10%)	2% (SD 8%)
Biopesticide 100%	1% (SD 6%)	2% (SD 7%)

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Scenario	DK	DE
Diversification	-14% (SD 14%)	NA
FMF 2m	9% (SD 15%)	-4% (SD 7%)
FMF 4m	14% (SD 16%)	-9% (SD 6%)
FMF 8m	17% (SD 19%)	-11% (SD 3%)
FMG 2m	1% (SD 9%)	-7% (SD 7%)
FMG 4m	3% (SD 5%)	-9% (SD 8%)
FMG 8m	6% (SD 17%)	-13% (SD 5%)
FMFG 50% 2m	6% (SD 7%)	-6% (SD 7%)
FMFG 50% 4m	12% (SD 13%)	-9% (SD 4%)
FMFG 50% 8m	11% (SD 13%)	-17% (SD 7%)
Set-Aside 4%	-11% (SD 8%)	-7% (SD 4%)
Set-Aside 7%	-18% (SD 12%)	-7% (SD 8%)
Set-Aside 10%	-20% (SD 14%)	-8% (SD 6%)
Legume 4%	-6% (SD 8%)	-6% (SD 7%)
Legume 7%	-11% (SD 10%)	-6% (SD 8%)
Legume 10%	-15% (SD 13%)	-4% (SD 10%)
Biopesticide 80%	-3% (SD 6%)	-1% (SD 5%)
Biopesticide 90%	2% (SD 7%)	-3% (SD 9%)
Biopesticide 95%	-0% (SD 10%)	2% (SD 8%)
Biopesticide 100%	1% (SD 6%)	2% (SD 7%)

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7 APHIDS

7.A BLACK BEAN APHID

7.1 Baselines across countries

7.1.1 Whole landscape

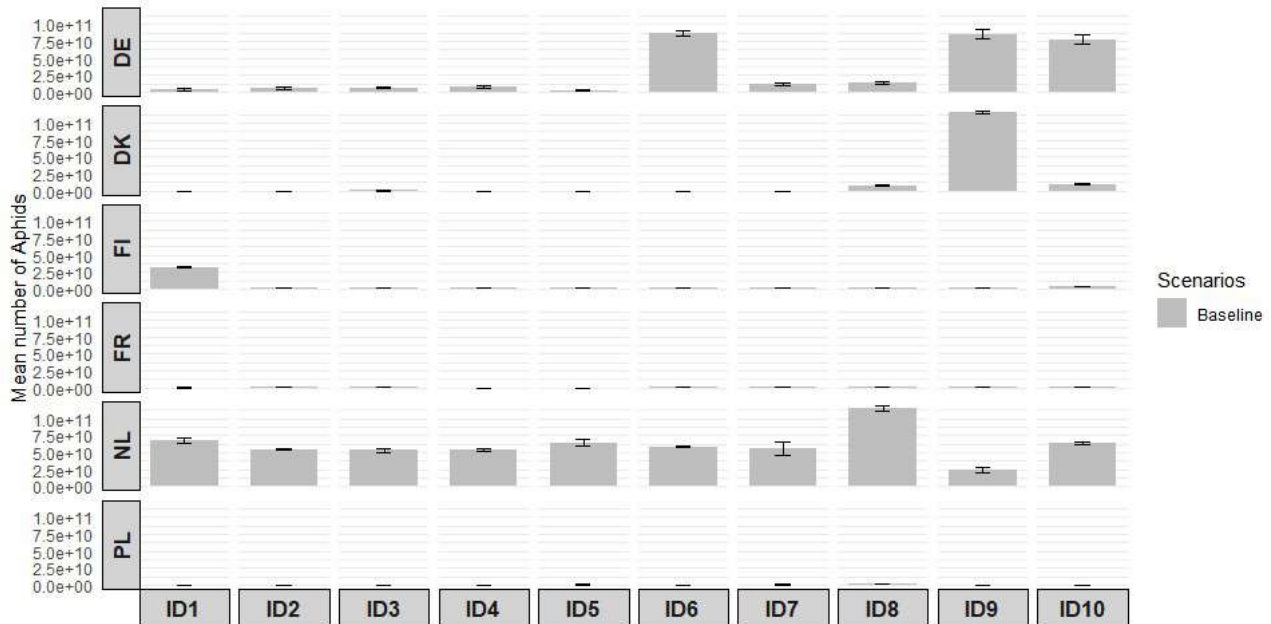


Figure 7.1 Black bean aphid baselines for each country and landscape.

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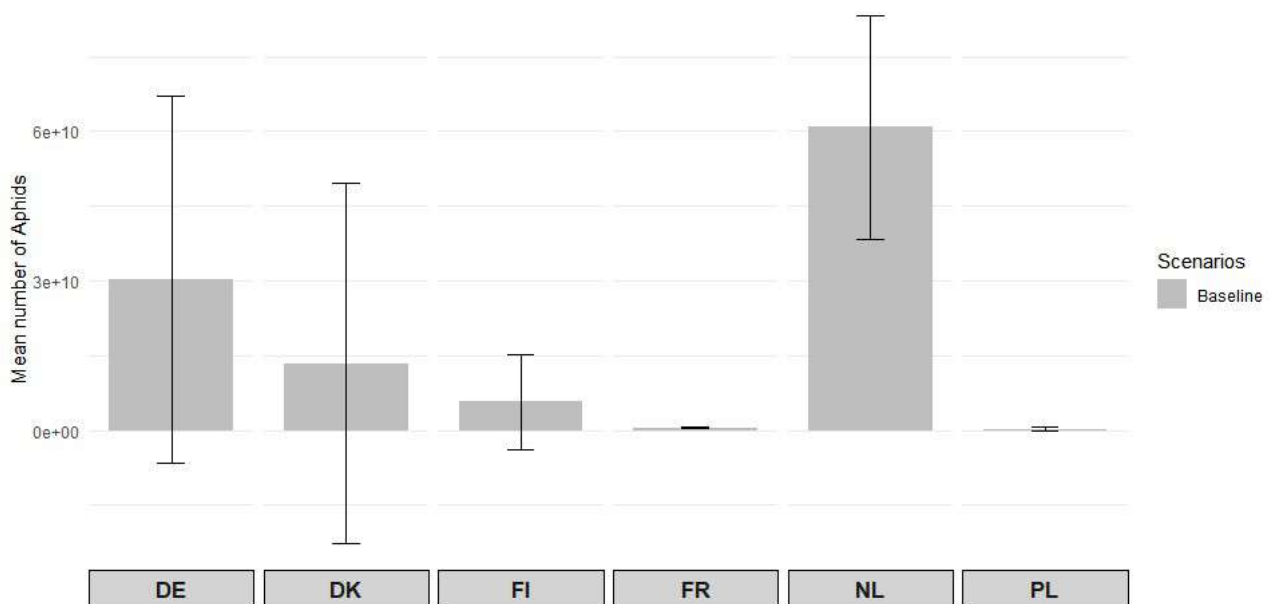


Figure 7.2 Black bean aphid baselines for each country combined across landscapes.

7.1.2 In-field

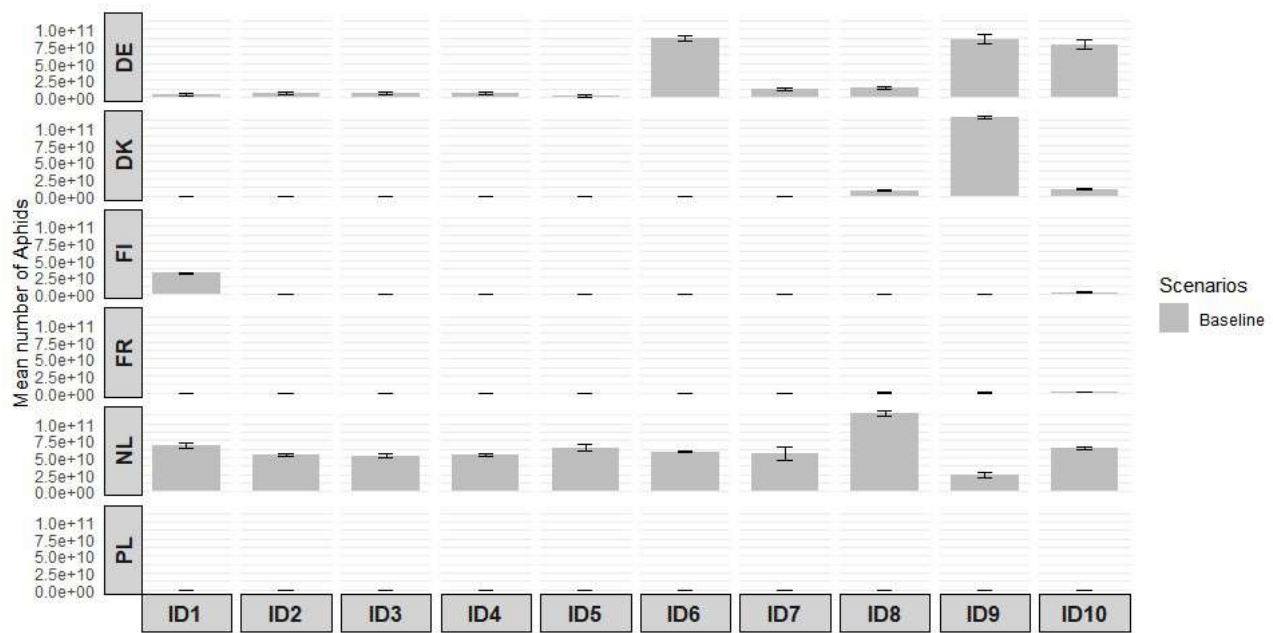


Figure 7.3 Black bean aphid baselines for each country and landscape. Black bean aphids in the fields only.

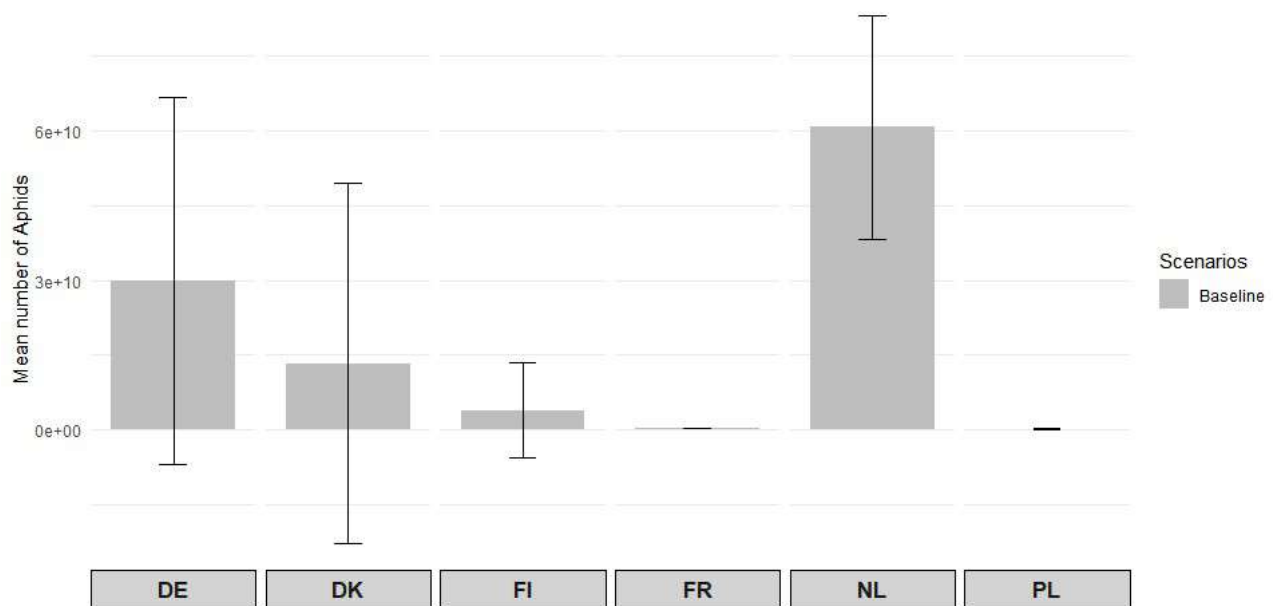


Figure 7.4 Black bean baselines for each country combined across landscapes. Black bean aphids in the fields only.

7.1.3 In-field relative to landscape

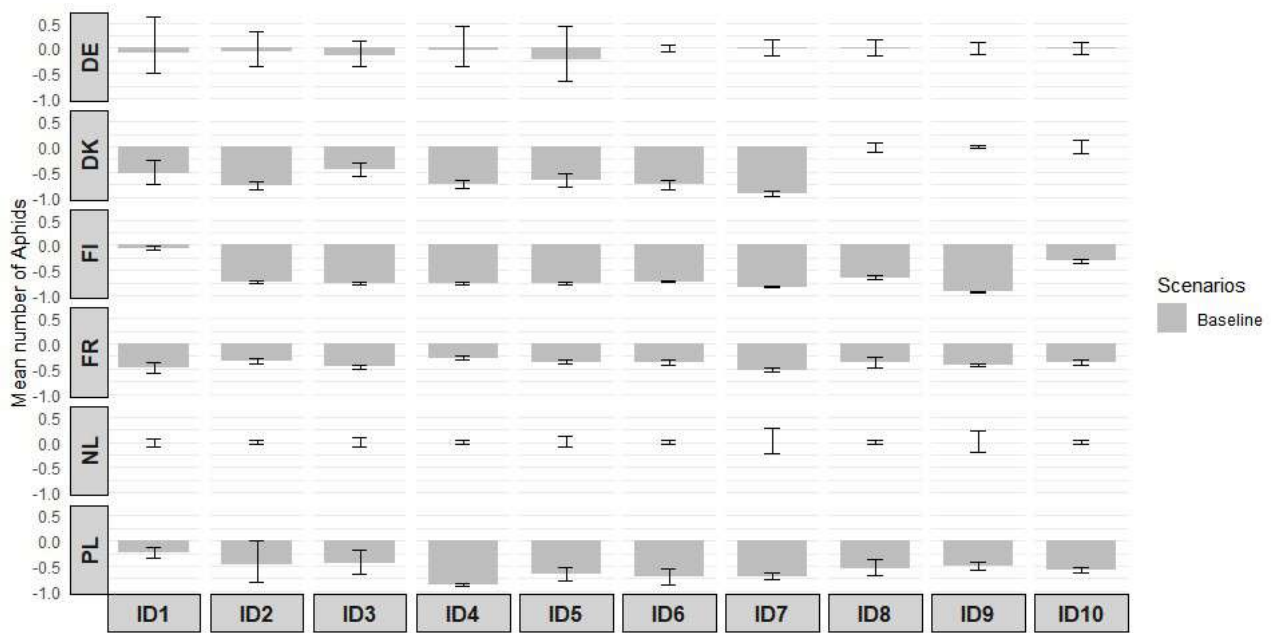


Figure 7.5 In-field relative to whole landscape comparison of Black bean aphid baseline runs across countries and landscapes.

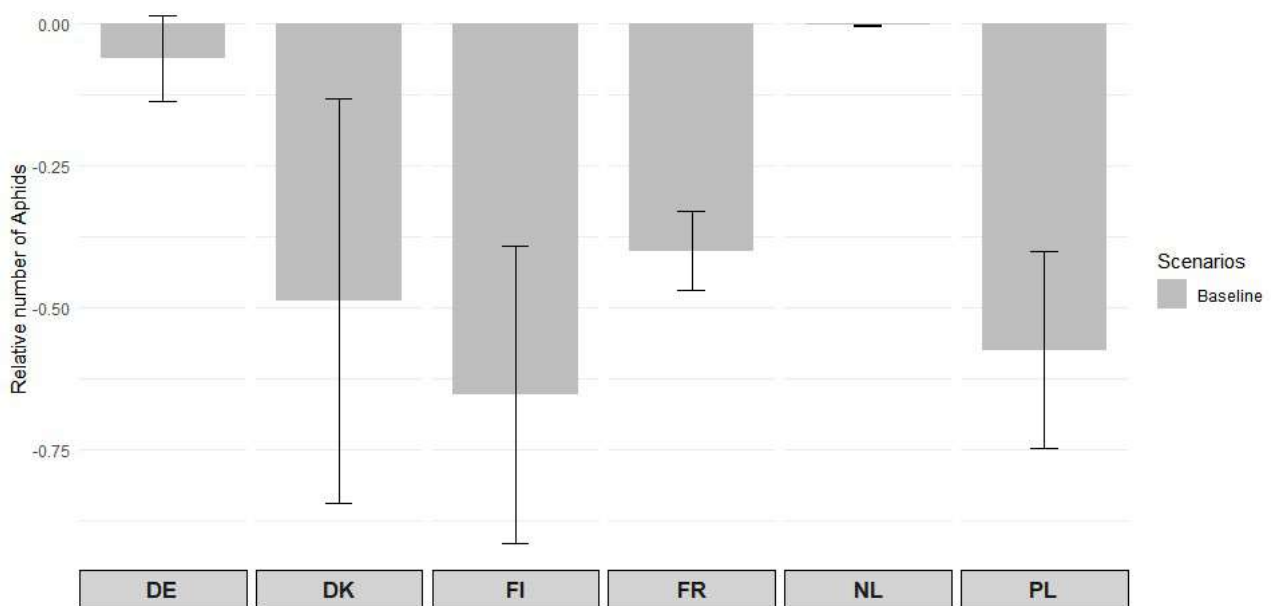


Figure 7.6 In-field relative to whole landscape comparison of Black bean aphid baseline for each country across landscapes.

7.2 Germany

7.2.1 Flower field margins

7.2.1.1 Whole landscape

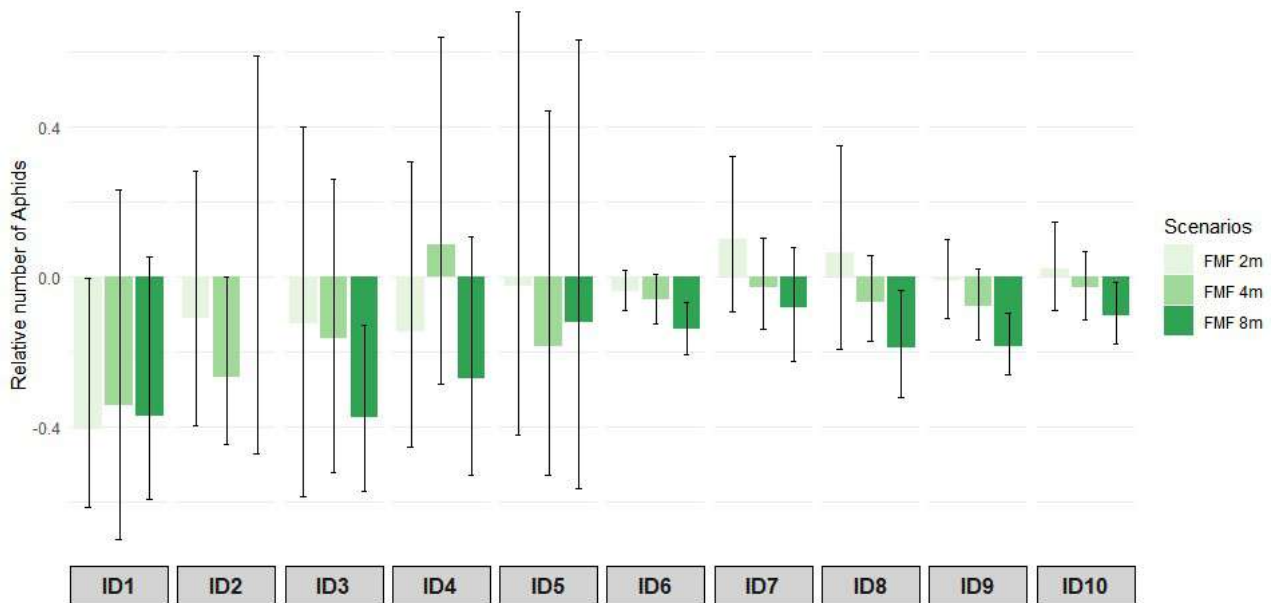


Figure 7.7 Flower field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

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7.2.1.2 In-field

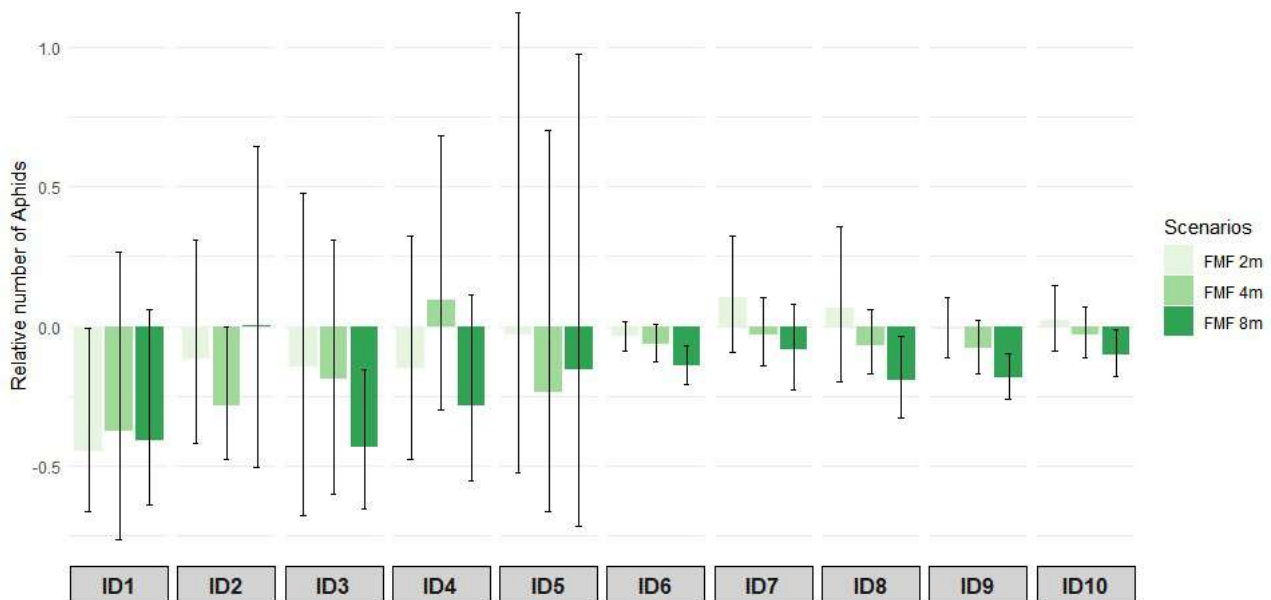


Figure 7.8 Flower field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.1.3 In-field relative to landscape

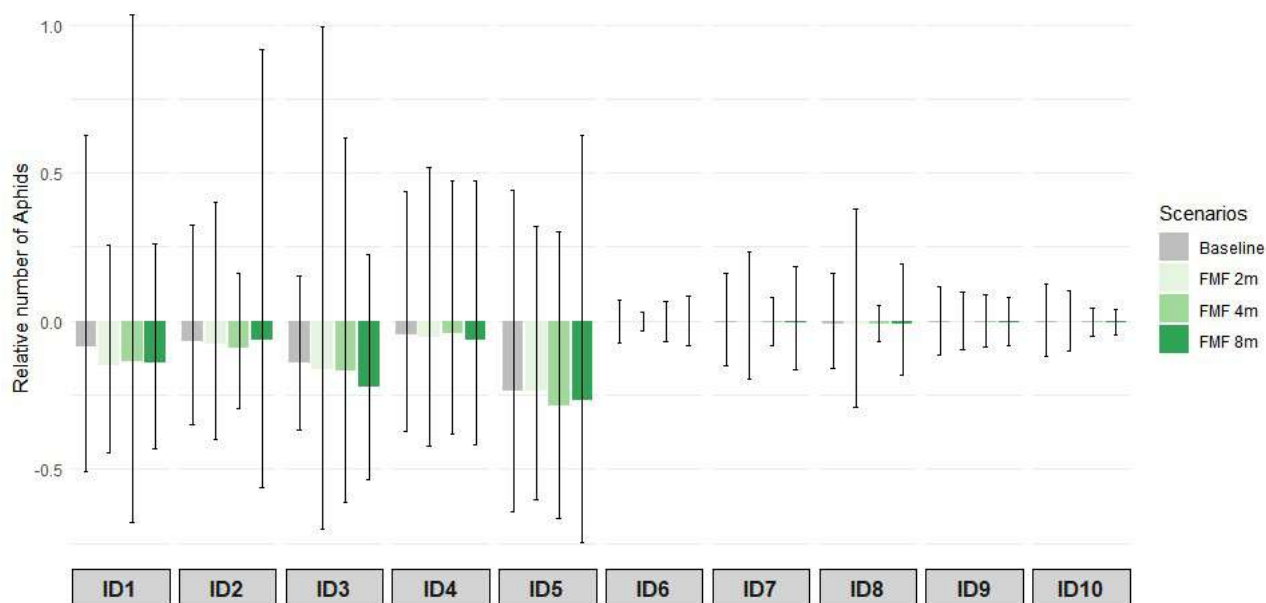


Figure 7.9 Flower field margins scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.2.2 Grass field margins

7.2.2.1 Whole landscape

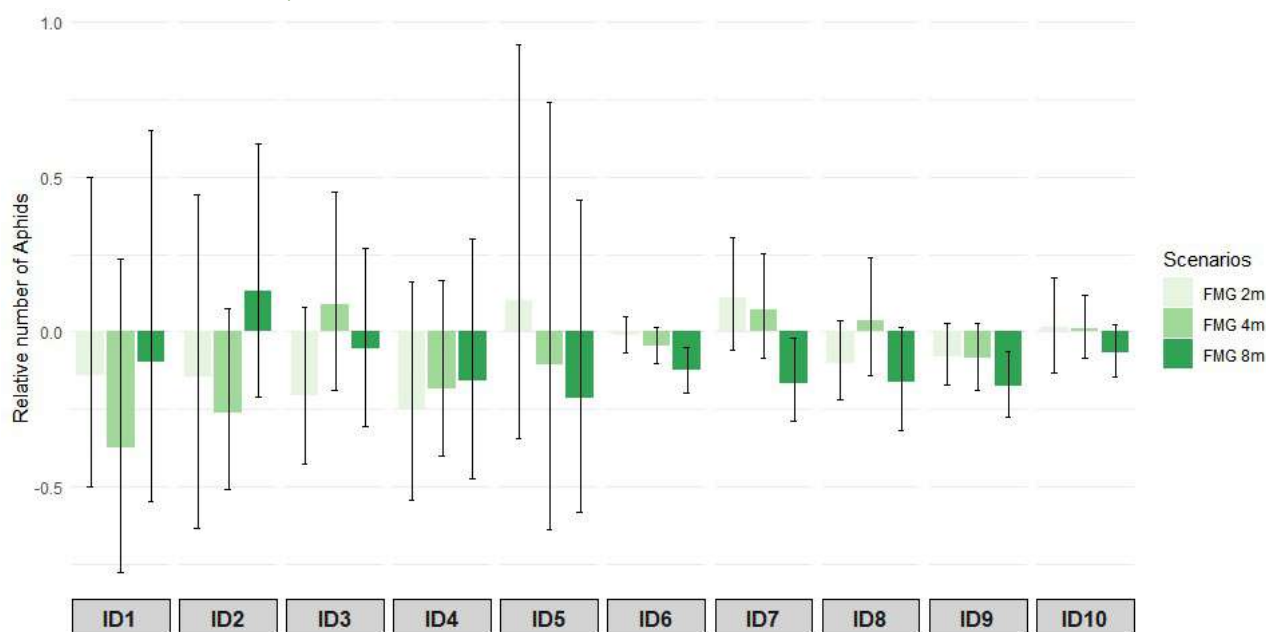


Figure 7.10 Grassy field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.2.2.2 In-field

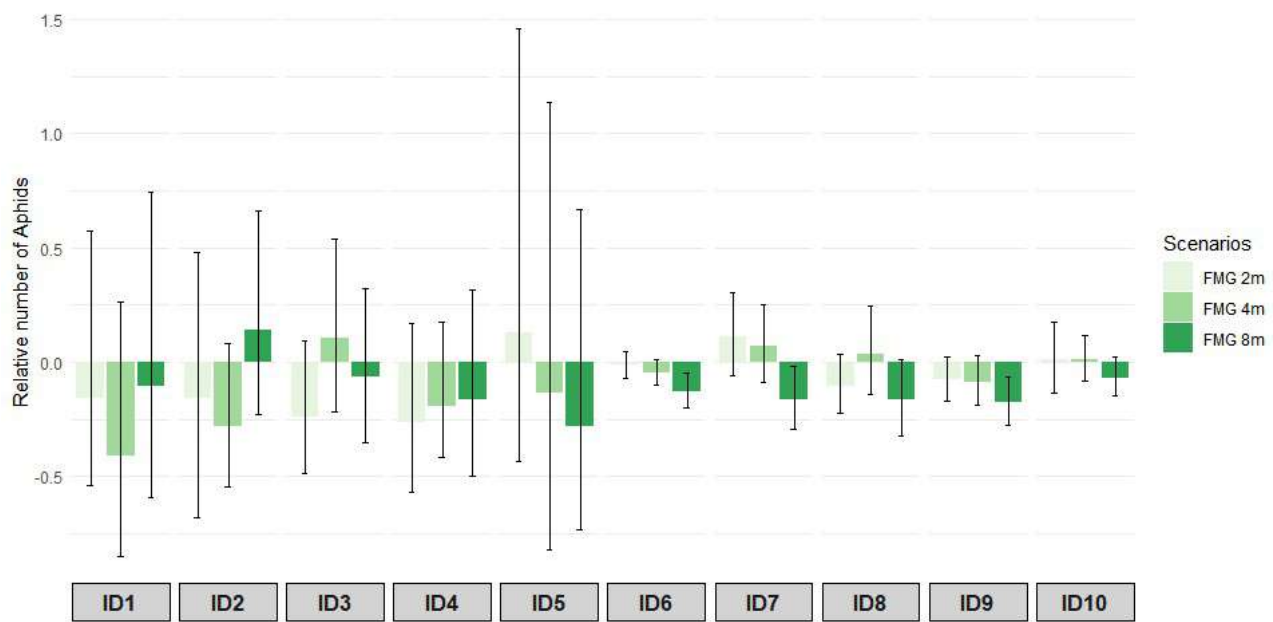


Figure 7.11 Grassy field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.2.3 In-field relative to landscape

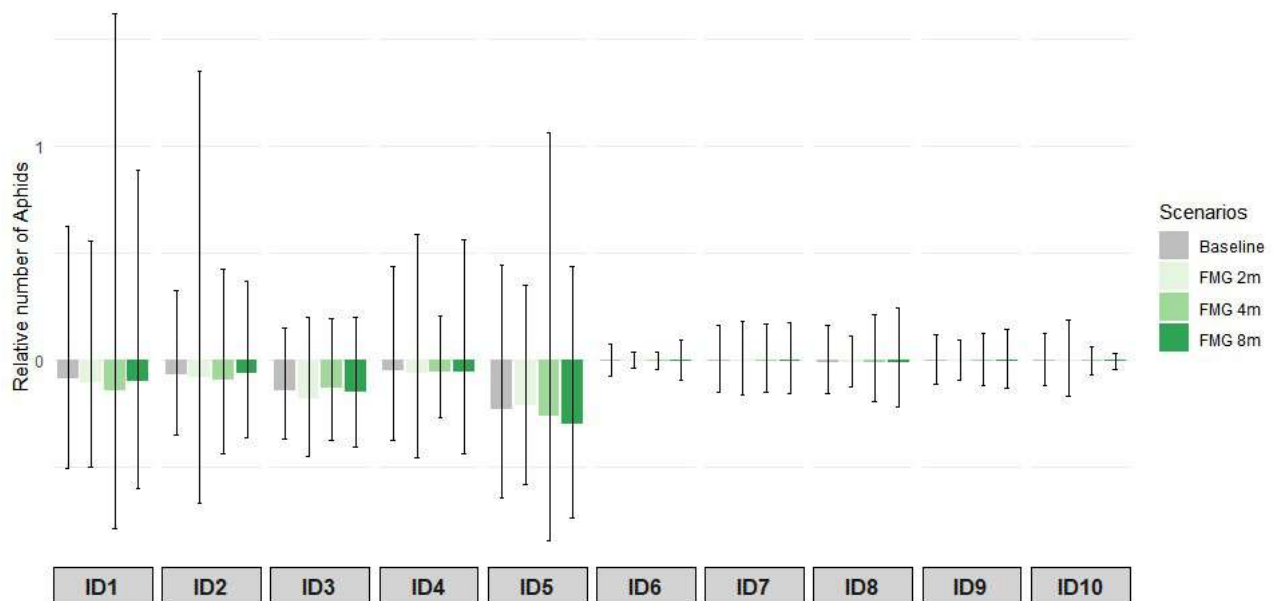


Figure 7.12 Grassy field margins scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.2.3 Mixed field margins

7.2.3.1 Whole landscape

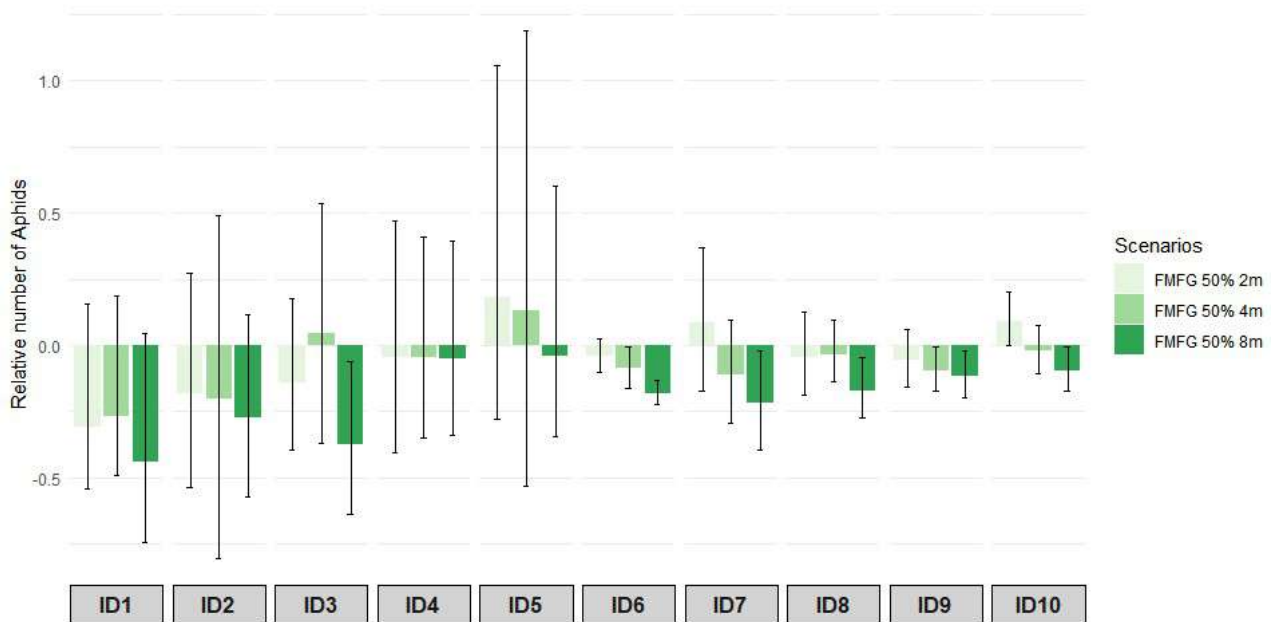


Figure 7.13 Mixed field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.2.3.2 In-field

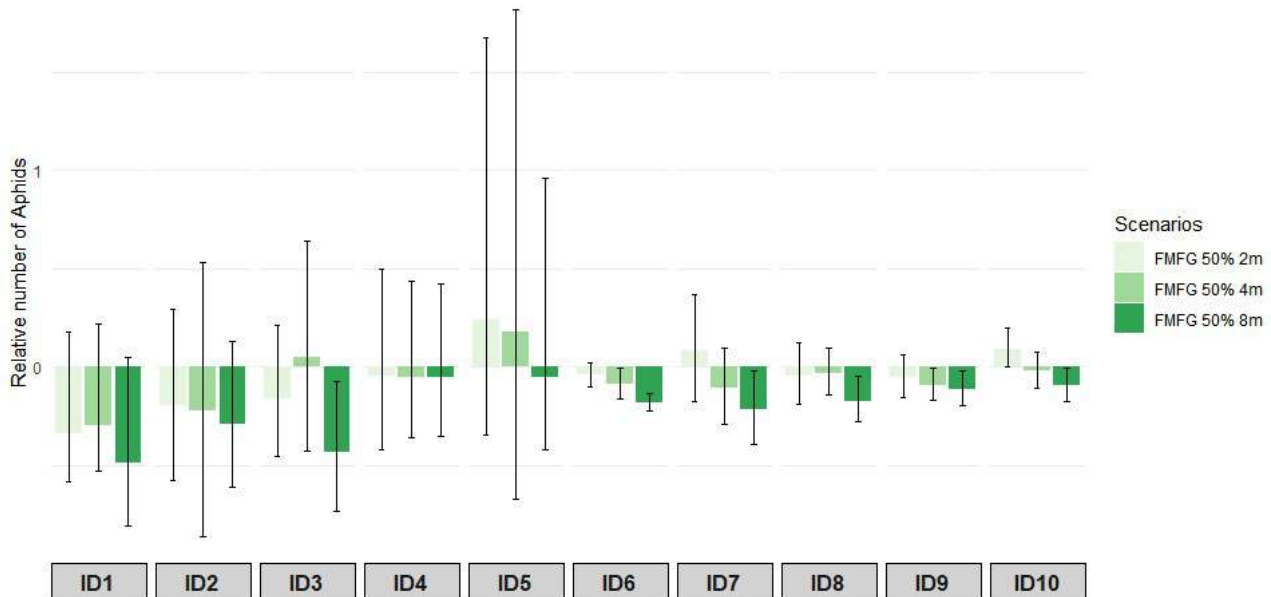


Figure 7.14 Mixed field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.3.3 In-field relative to landscape

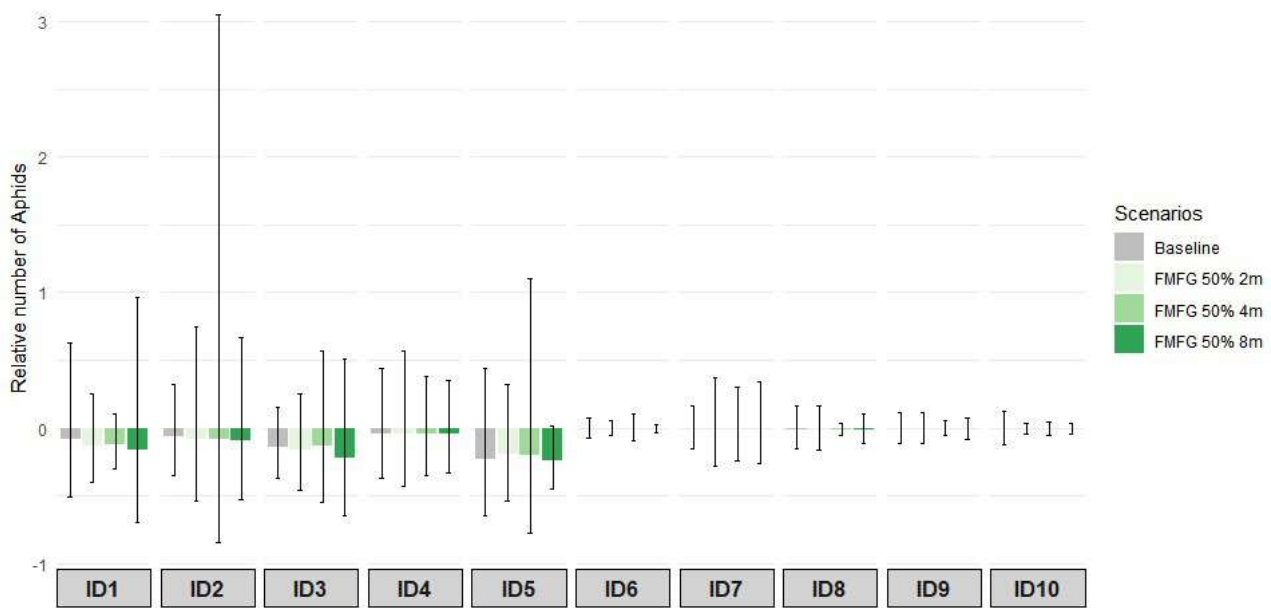


Figure 7.15 Mixed field margins scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.2.4 Flower, grassy and mixed margins

7.2.4.1 Whole landscape

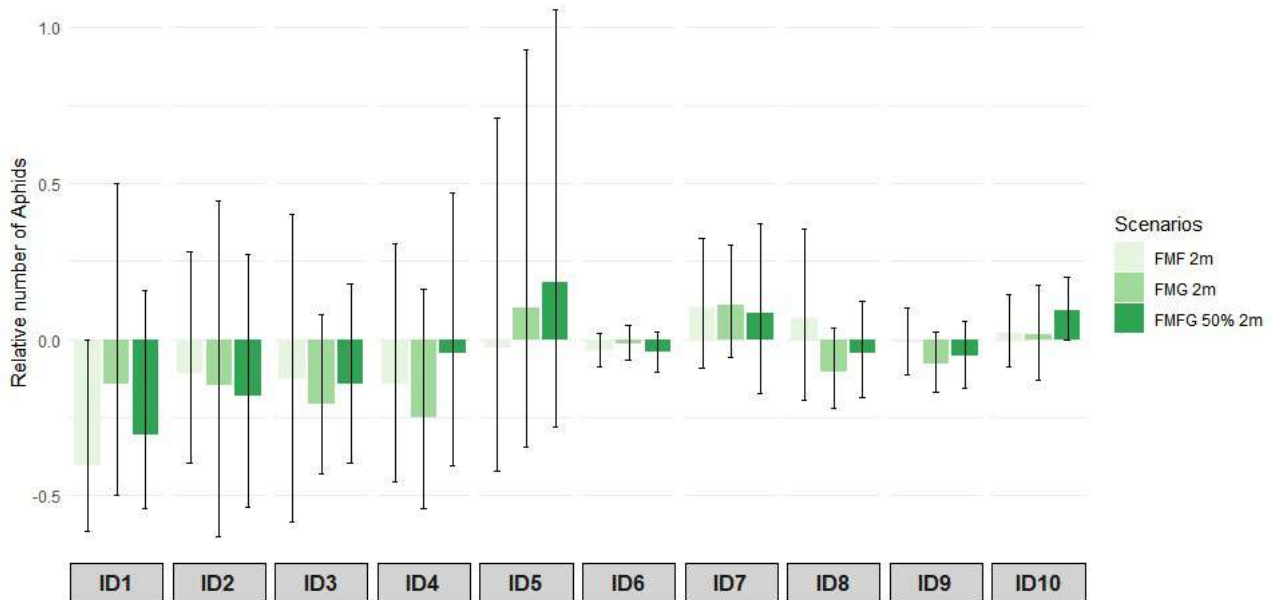


Figure 7.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

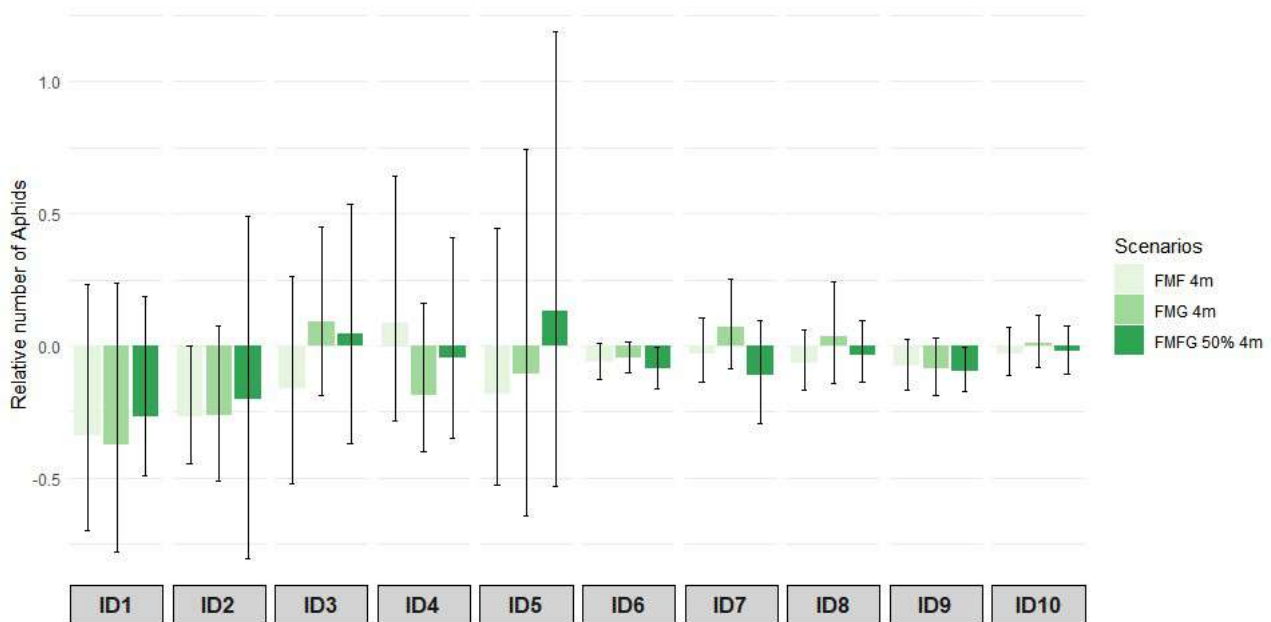


Figure 7.17 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

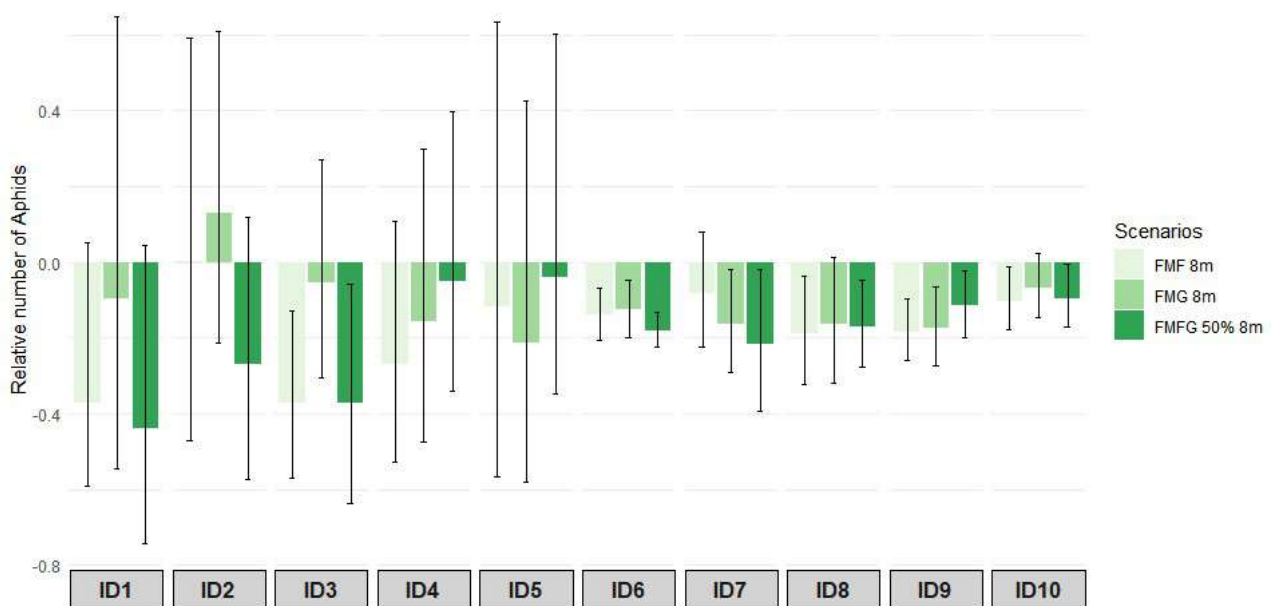


Figure 7.18 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.2.4.2 In-field

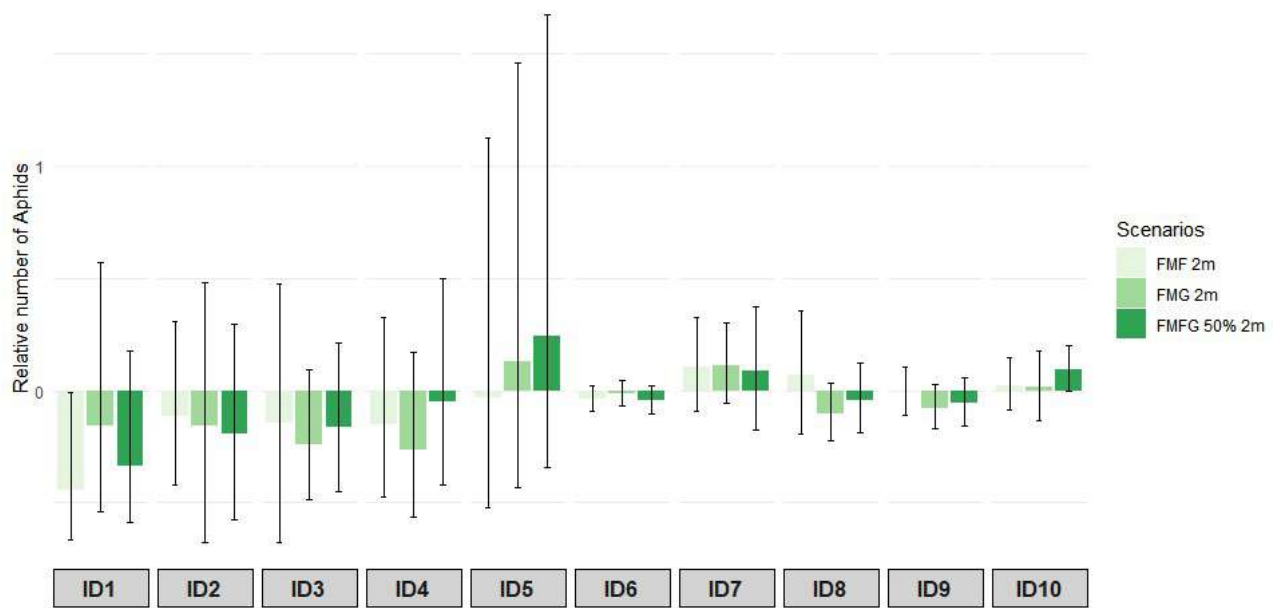


Figure 7.19 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

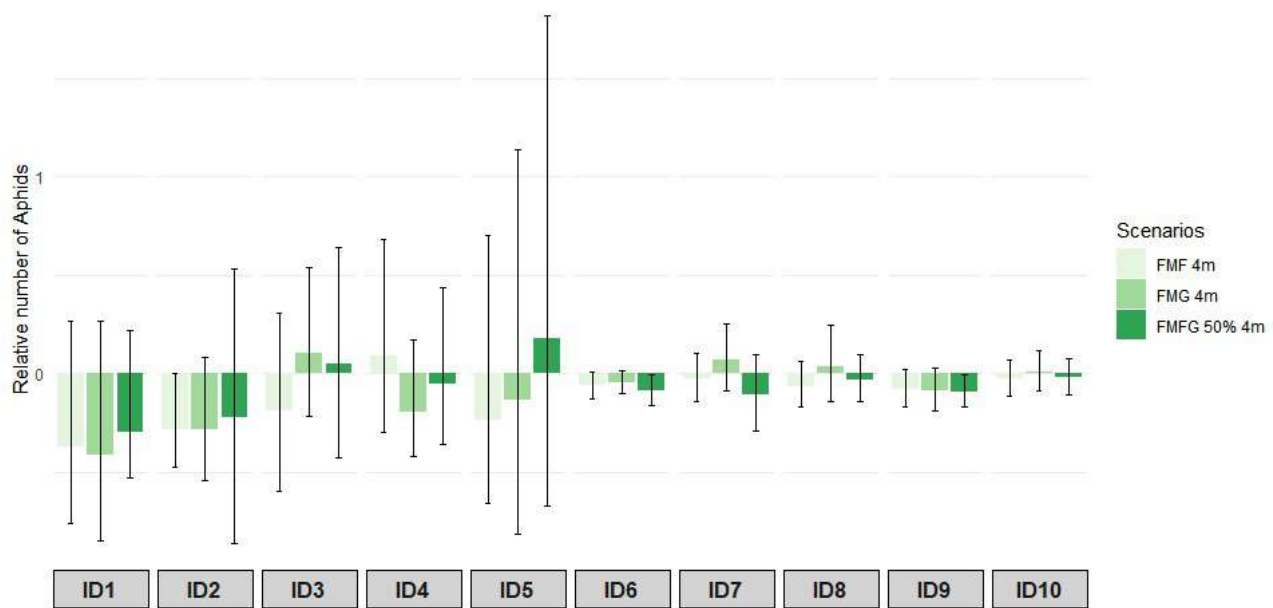


Figure 7.20 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

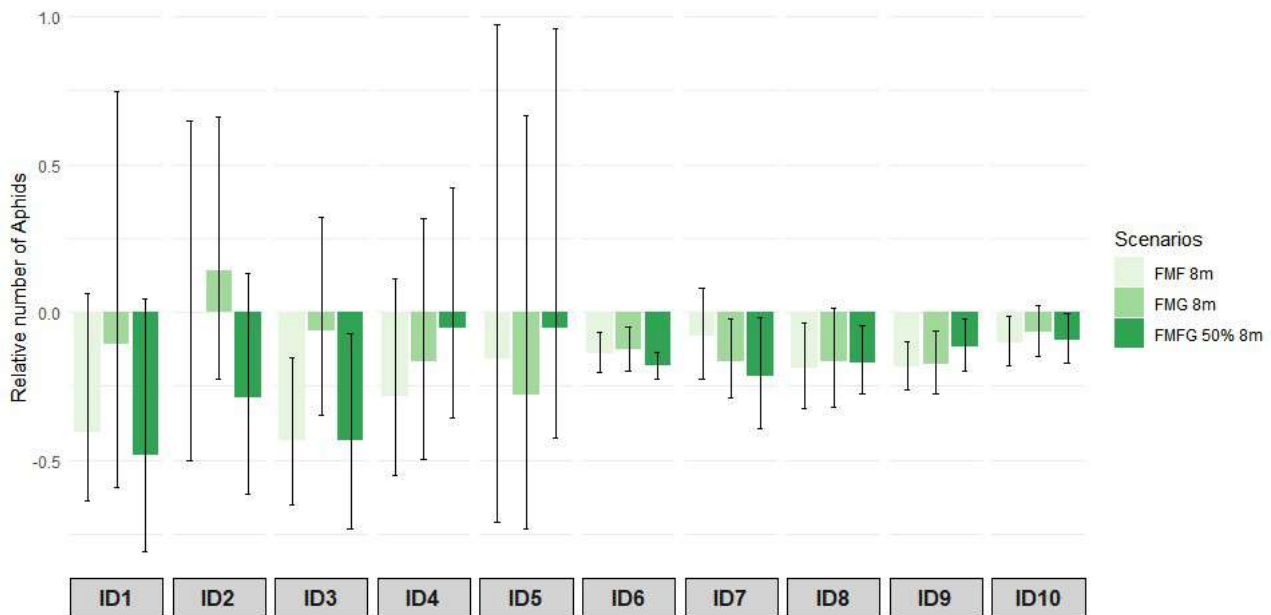


Figure 7.21 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.4.3 In-field relative to landscape

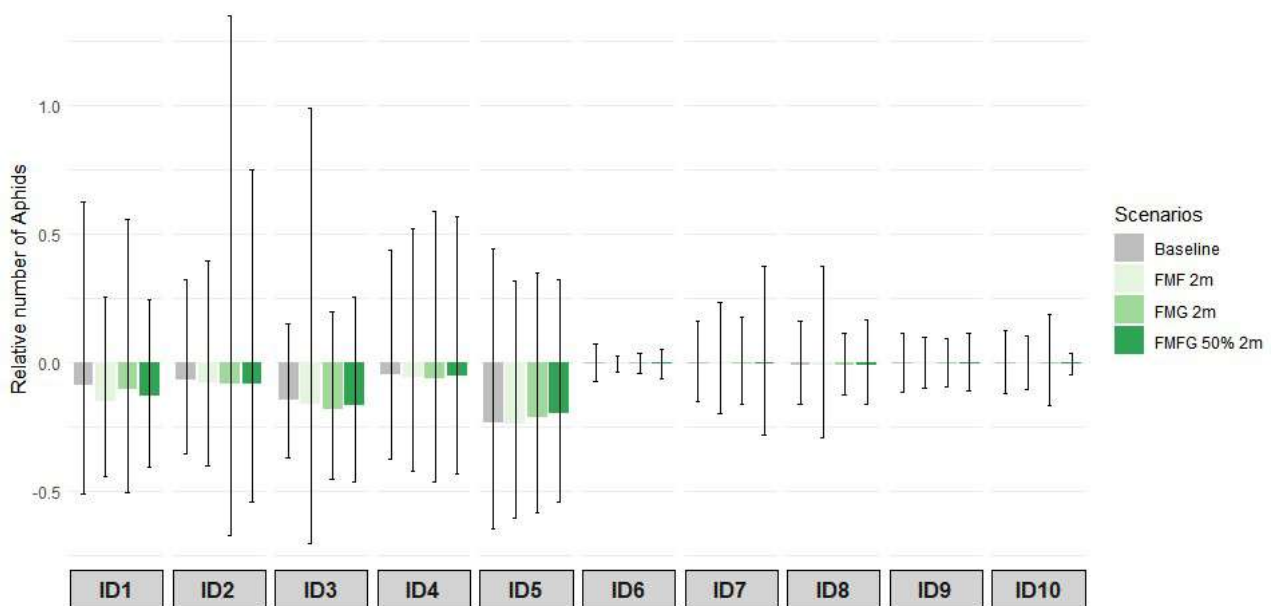


Figure 7.22 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

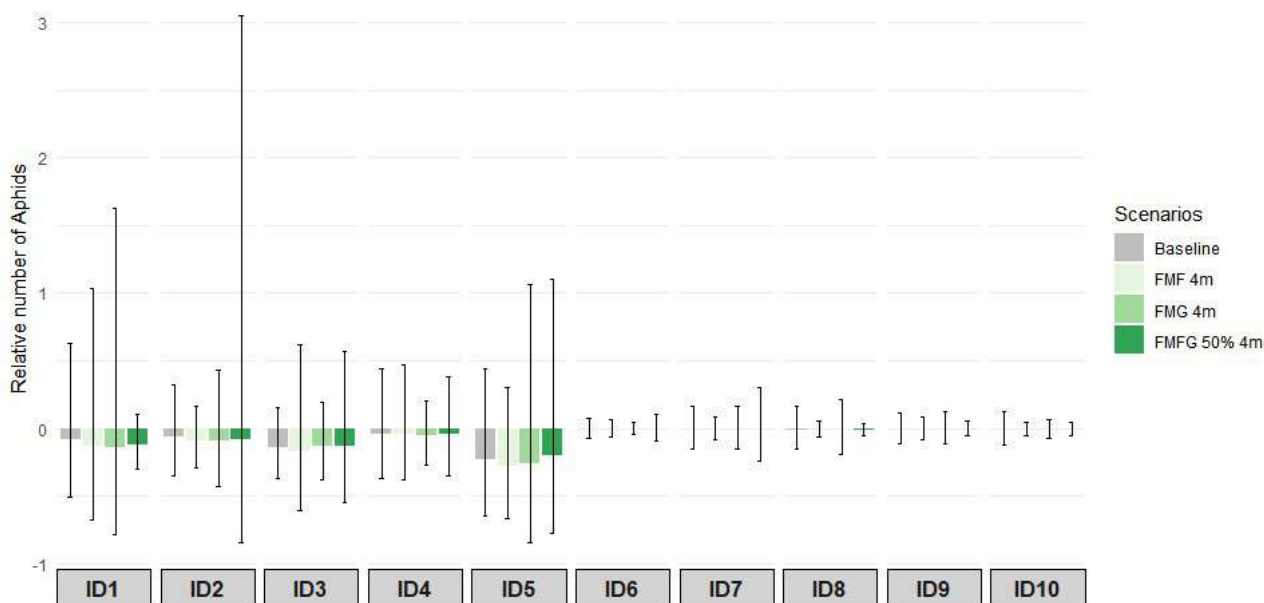


Figure 7.23 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

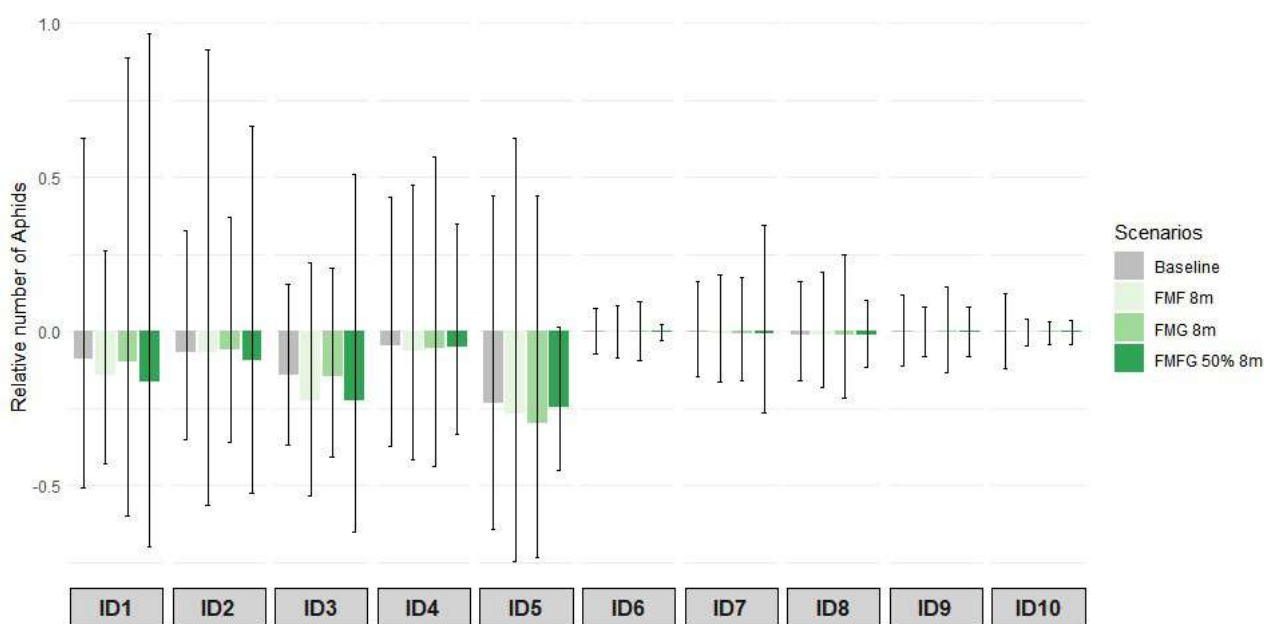


Figure 7.24 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.2.5 Setaside

7.2.5.1 Whole landscape

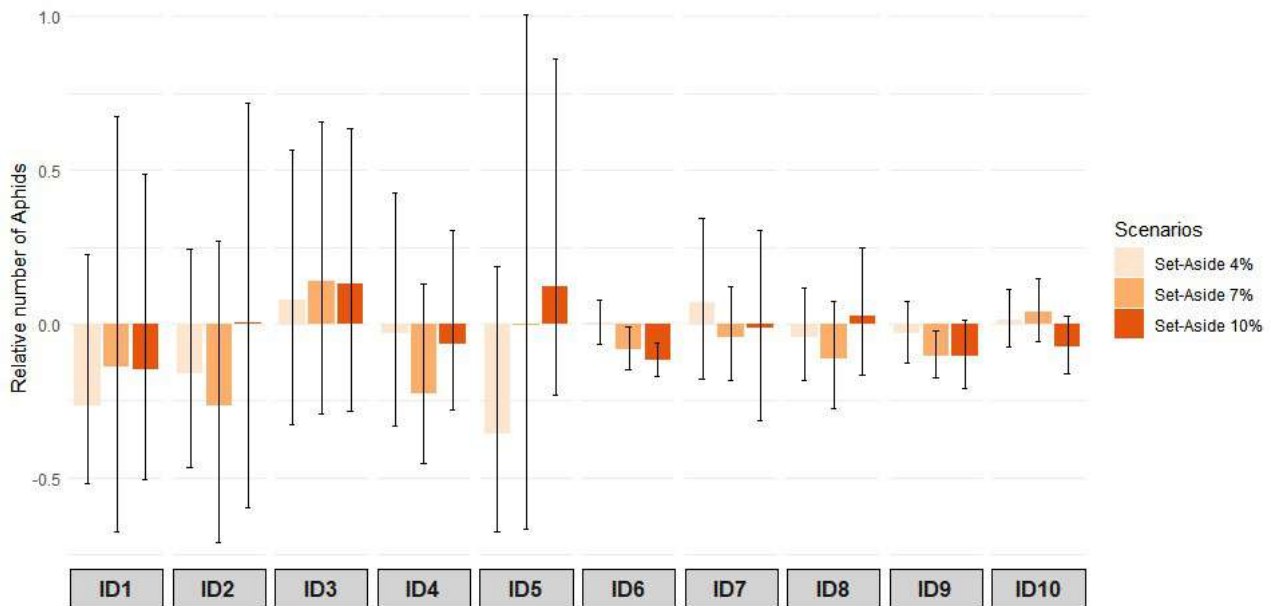


Figure 7.25 Setaside scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.2.5.2 In-field

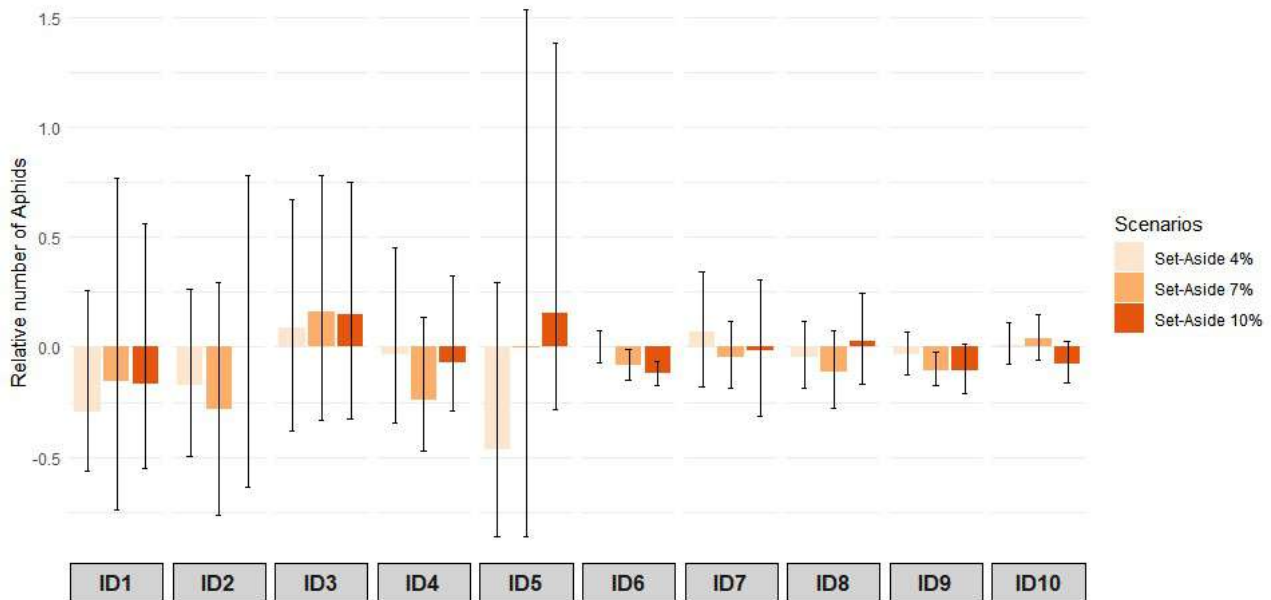


Figure 7.26 Setaside scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.5.3 In-field relative to landscape

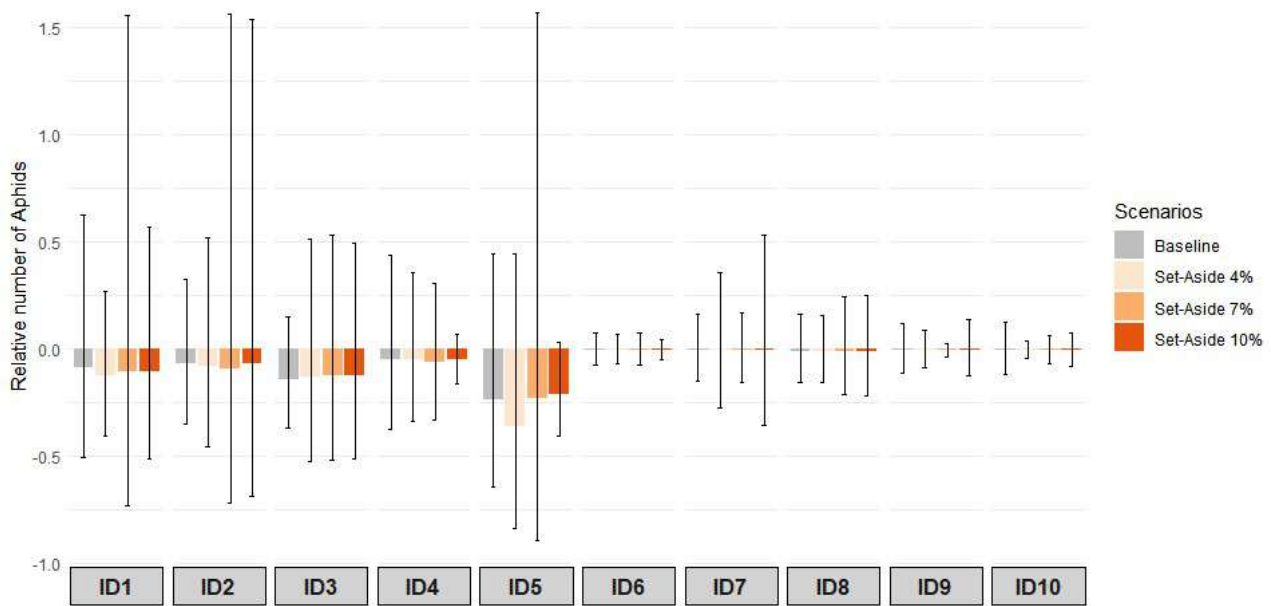


Figure 7.27 Setaside scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.2.6 Legume

7.2.6.1 Whole landscape

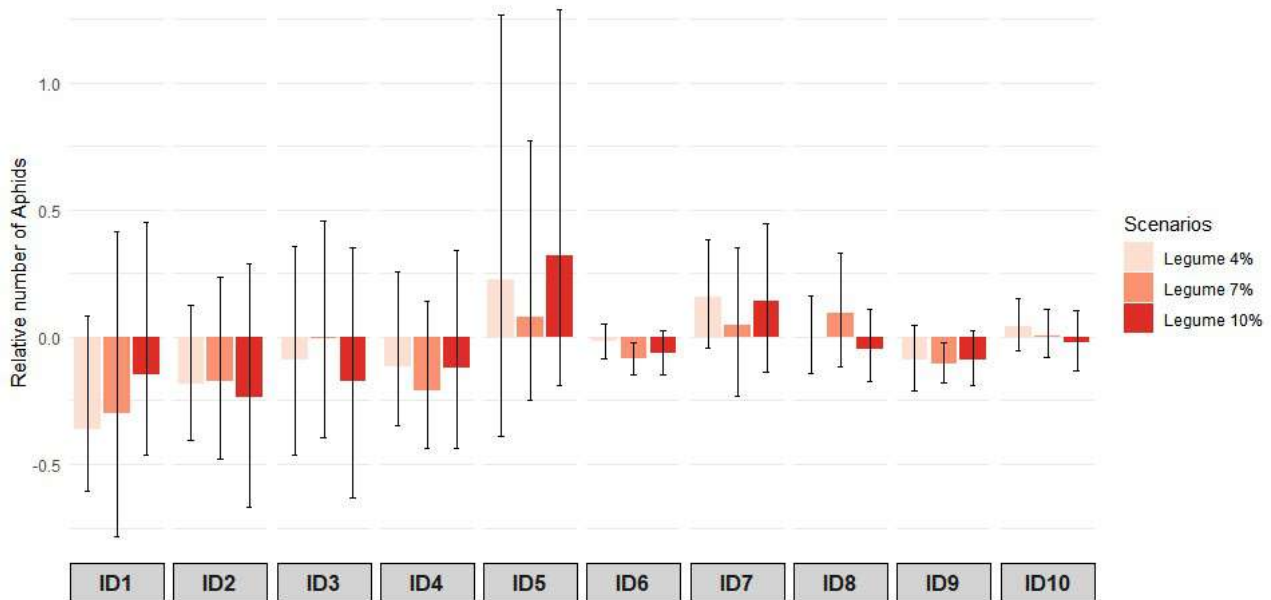


Figure 7.28 Legume scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.2.6.2 In-field

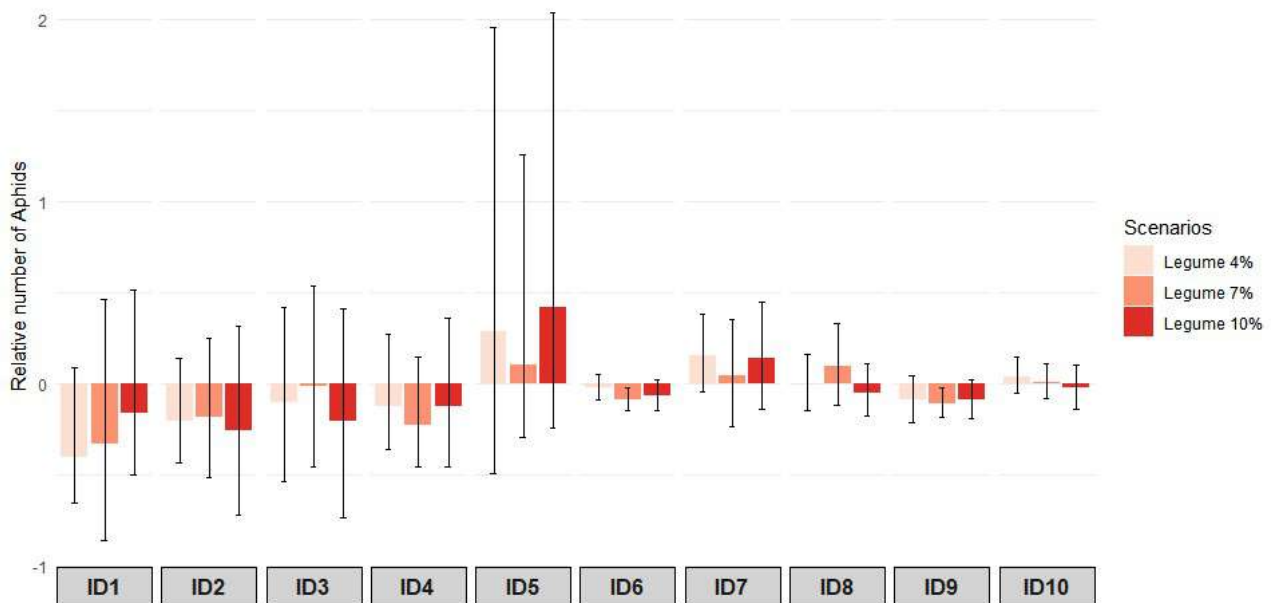


Figure 7.29 Legume scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.6.3 In-field relative to landscape

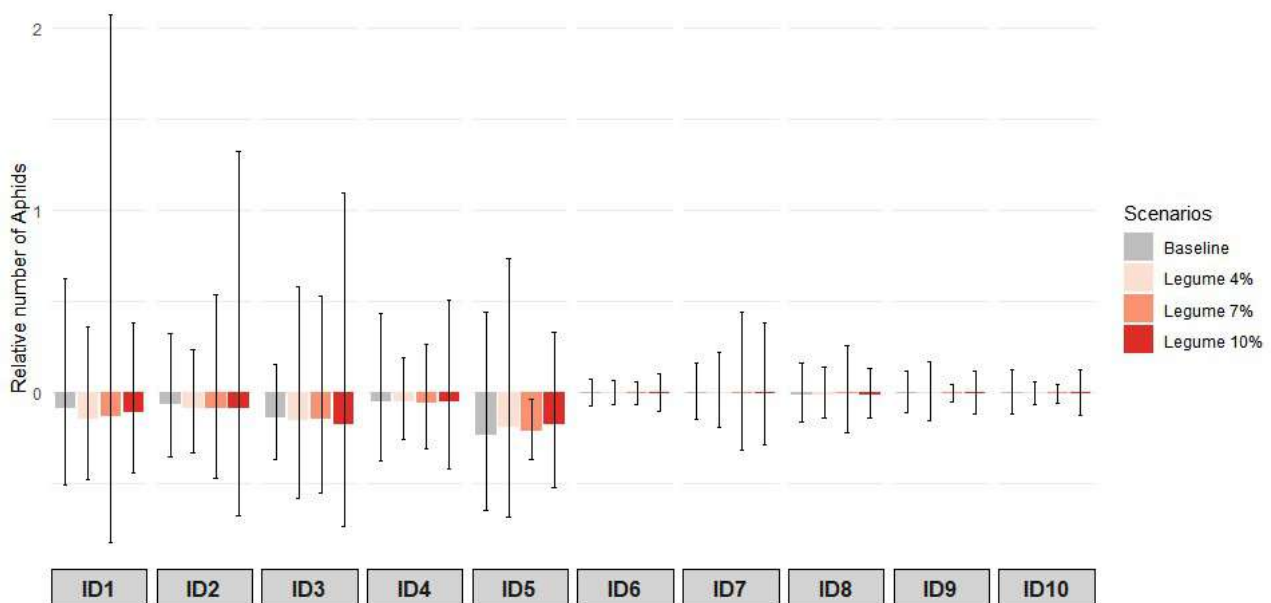


Figure 7.30 Legume scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.2.7 Biopesticides

7.2.7.1 Whole landscape

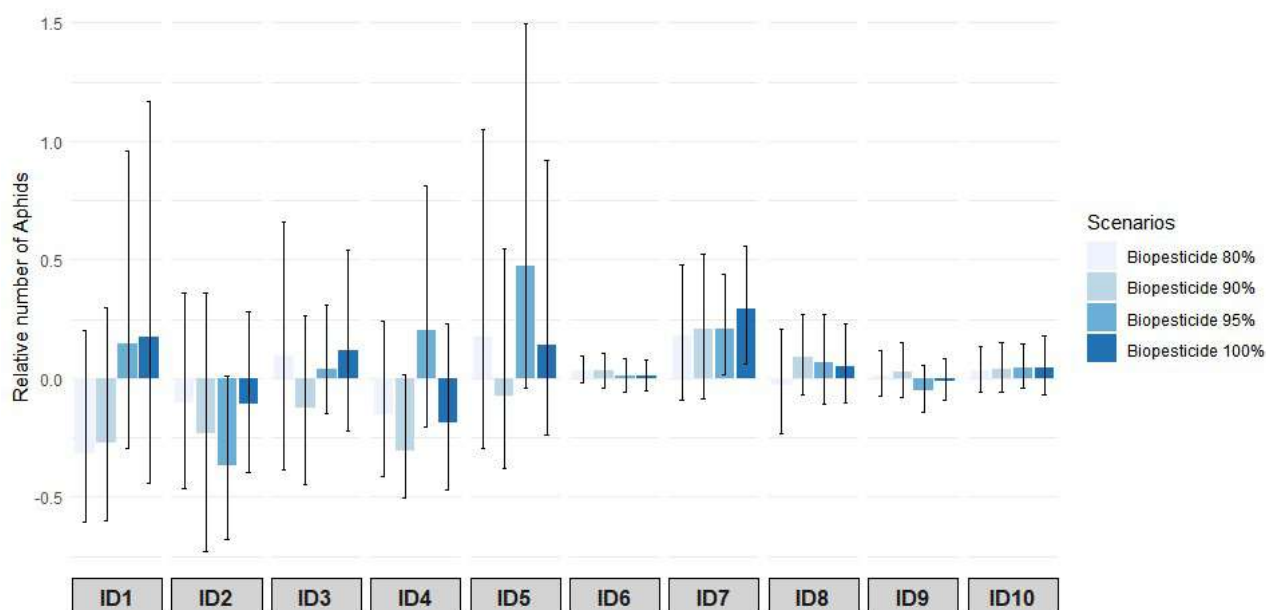


Figure 7.31 Biopesticide scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.2.7.2 In-field

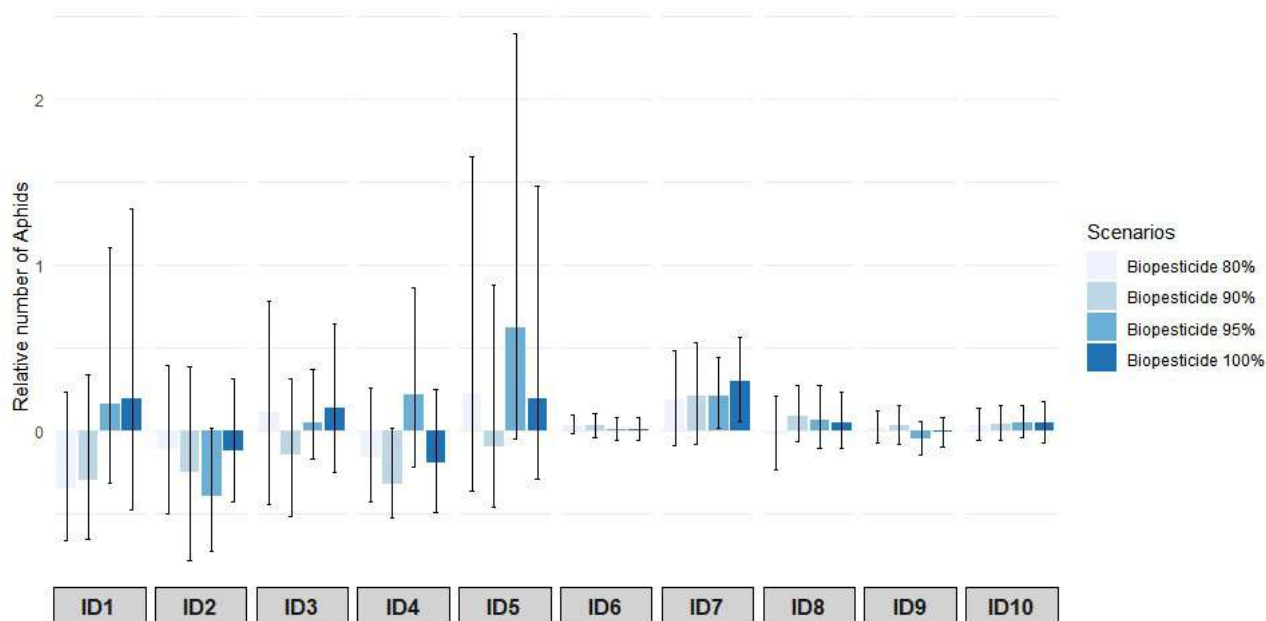


Figure 7.32 Biopesticide scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.2.7.3 In-field relative to landscape

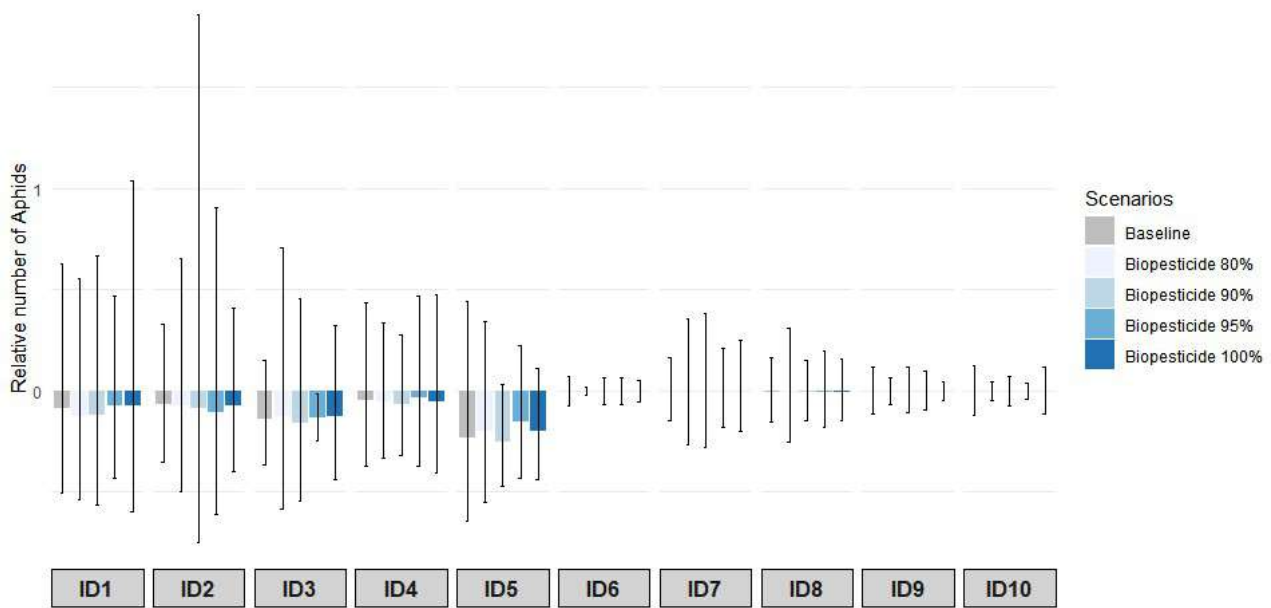


Figure 7.33 Biopesticide scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.3 Denmark

7.3.1 Crop diversification

7.3.1.1 Whole landscape

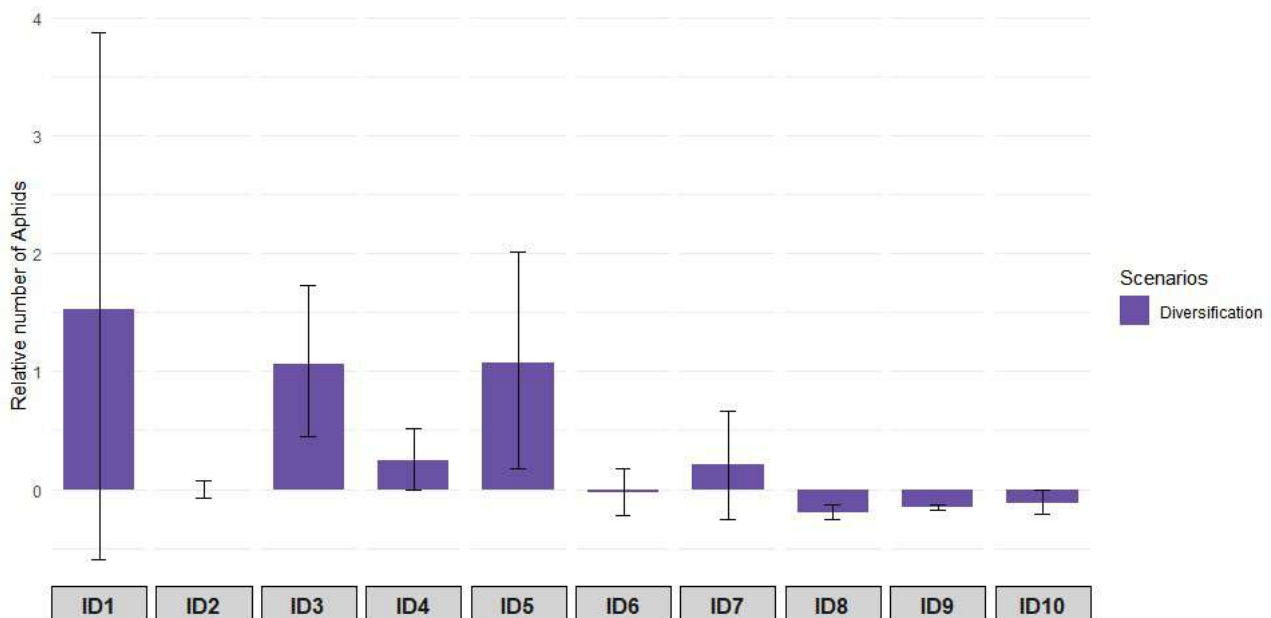


Figure 7.34 Diversification scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.1.2 In-field

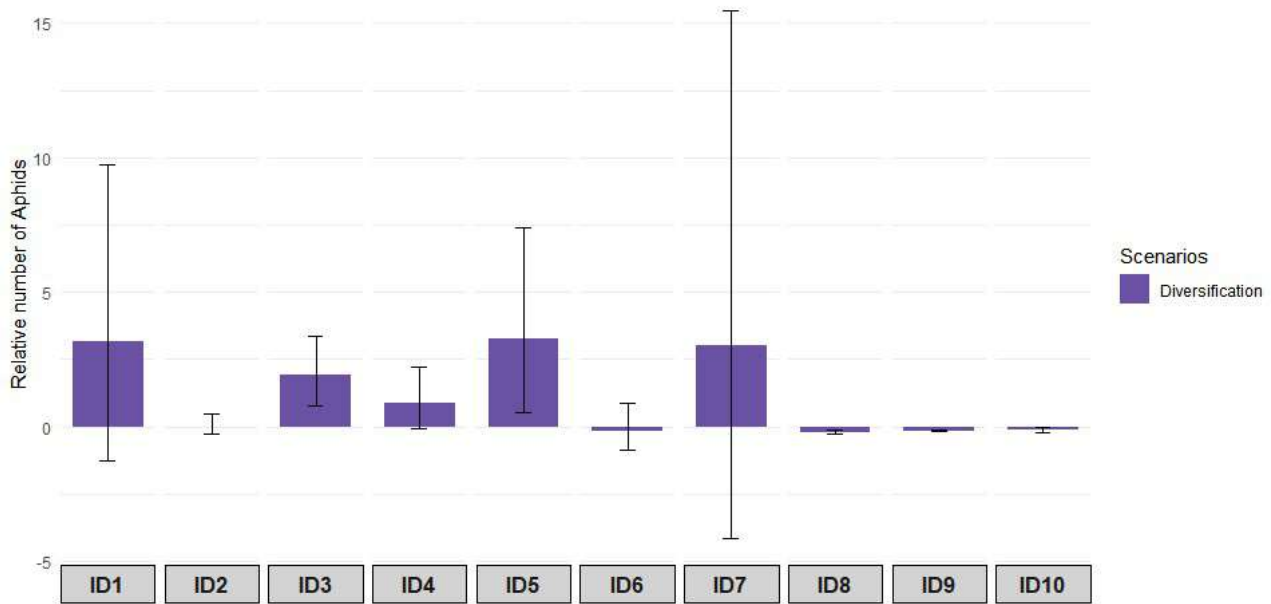


Figure 7.35 Diversification scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.1.3 In-field relative to landscape

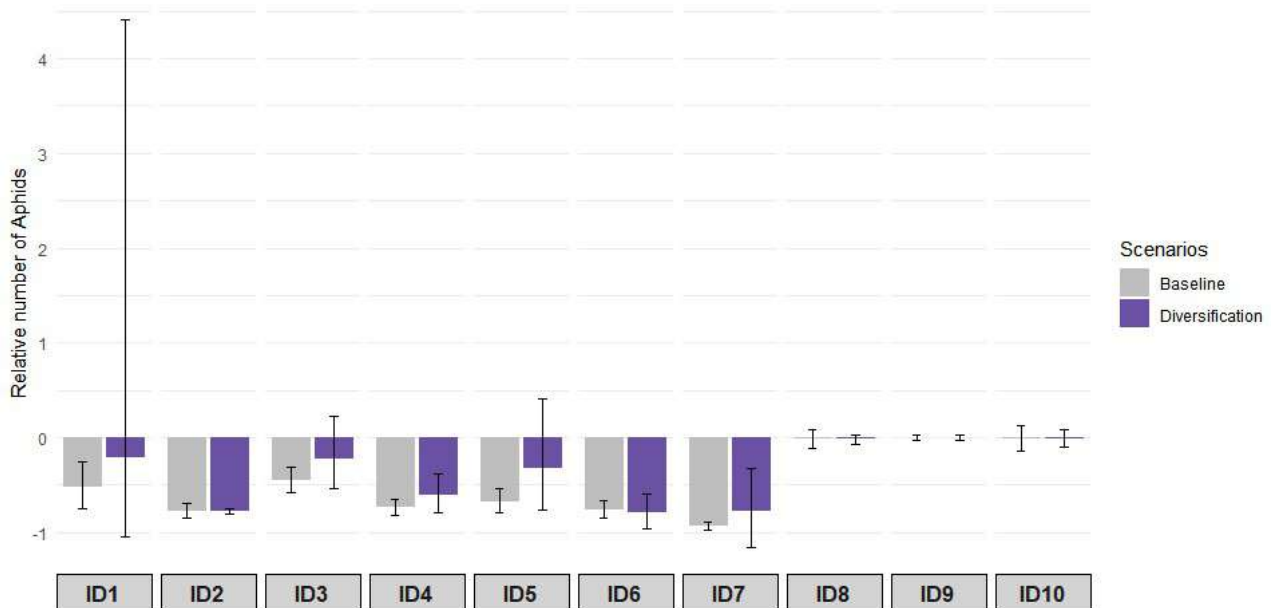


Figure 7.36 Diversification scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.2 Flower field margins

7.3.2.1 Whole landscape

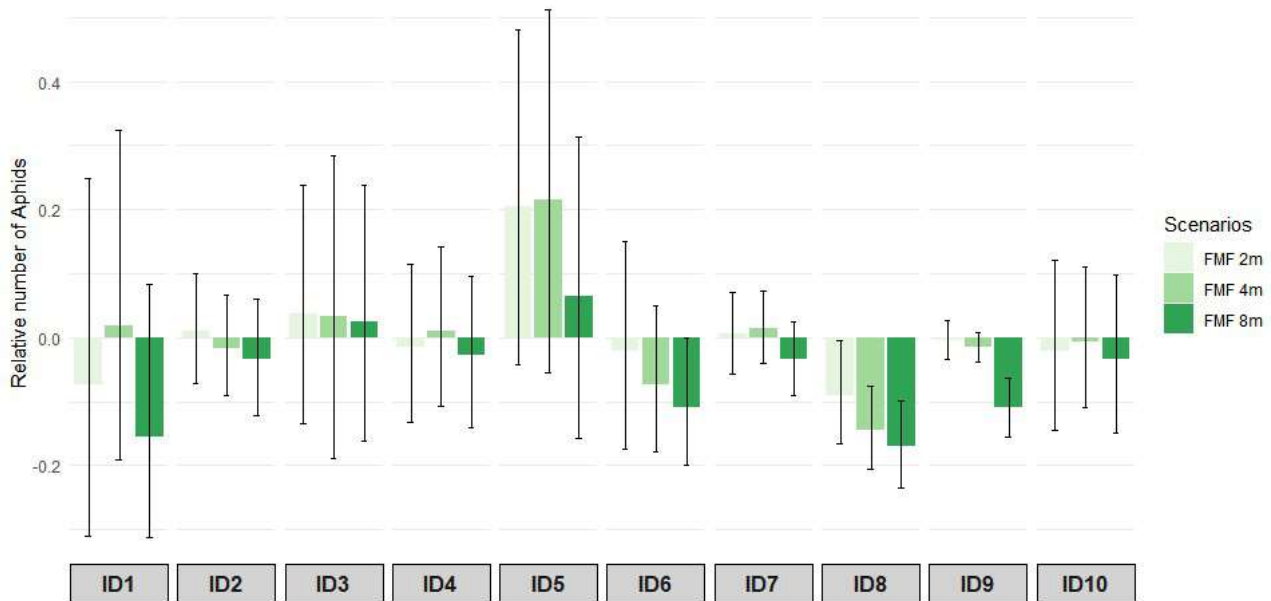


Figure 7.37 Flower field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.2.2 In-field

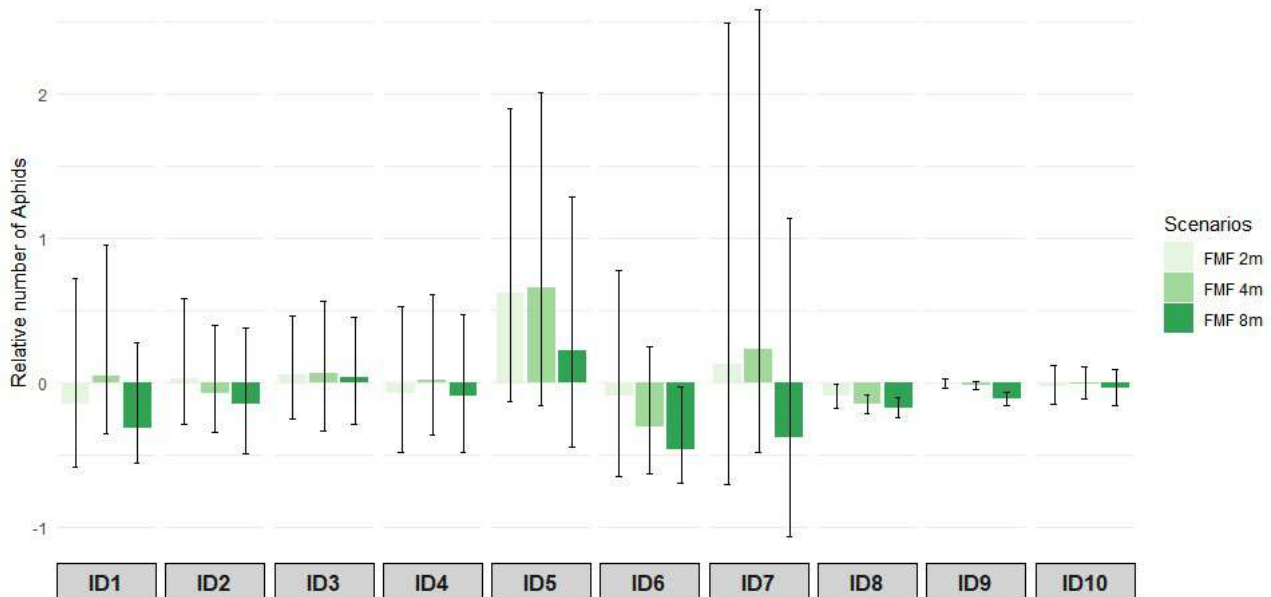


Figure 7.38 Flower field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.2.3 In-field relative to landscape

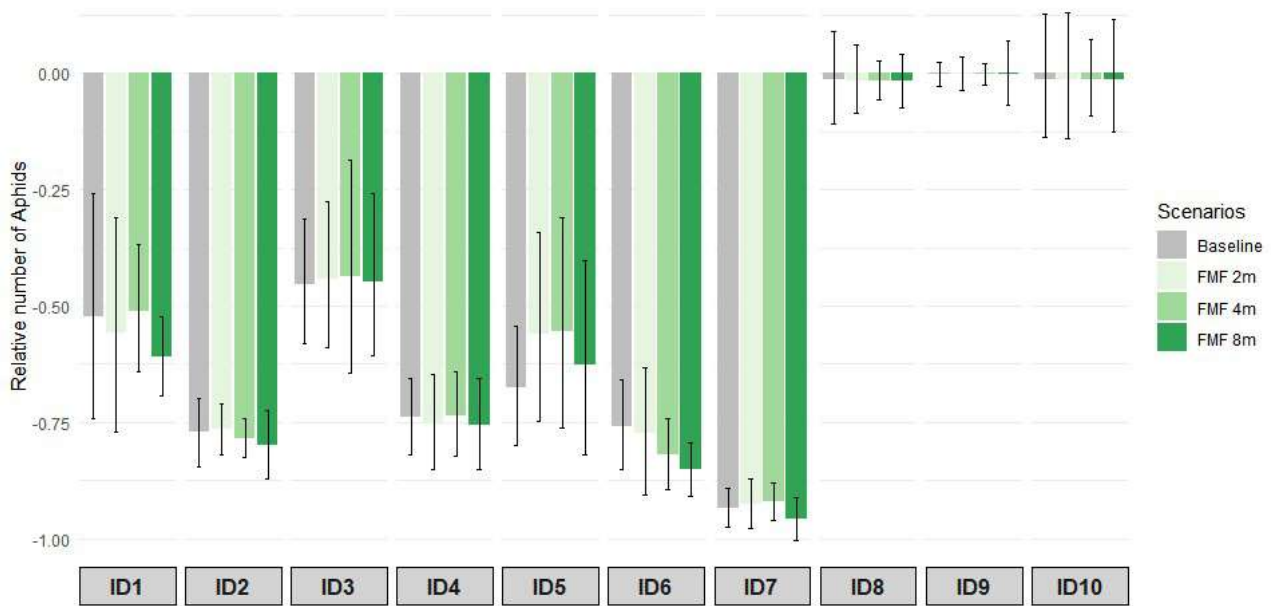


Figure 7.39 Flower field margins scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.3 Grass field margins

7.3.3.1 Whole landscape

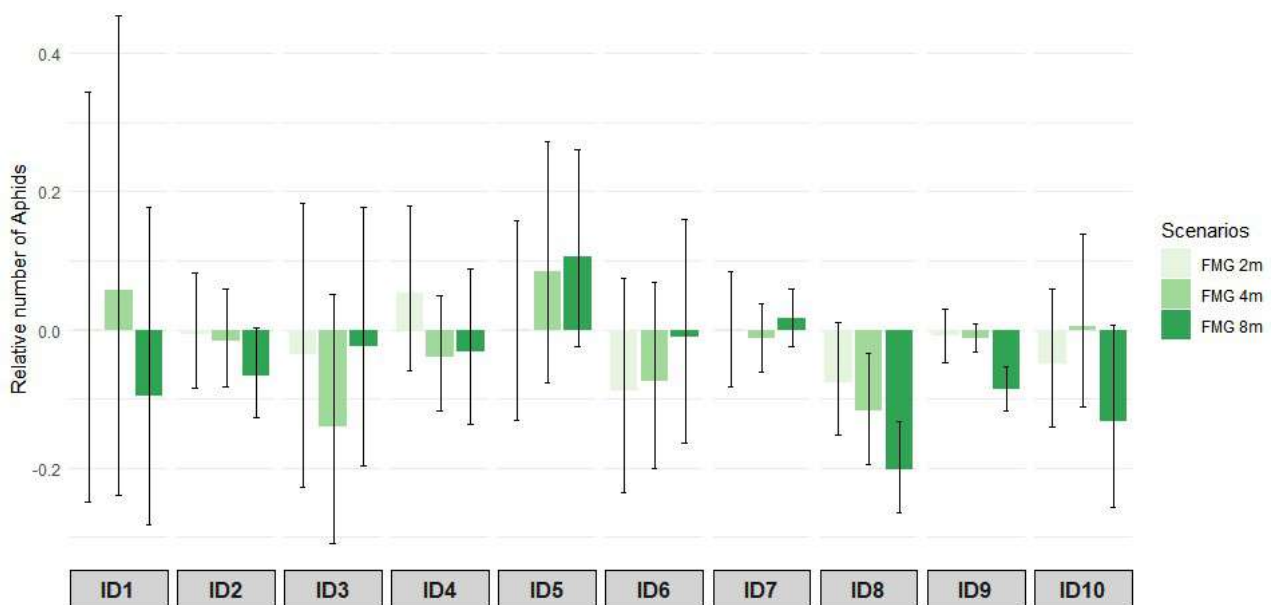


Figure 7.40 Grassy field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.3.2 In-field

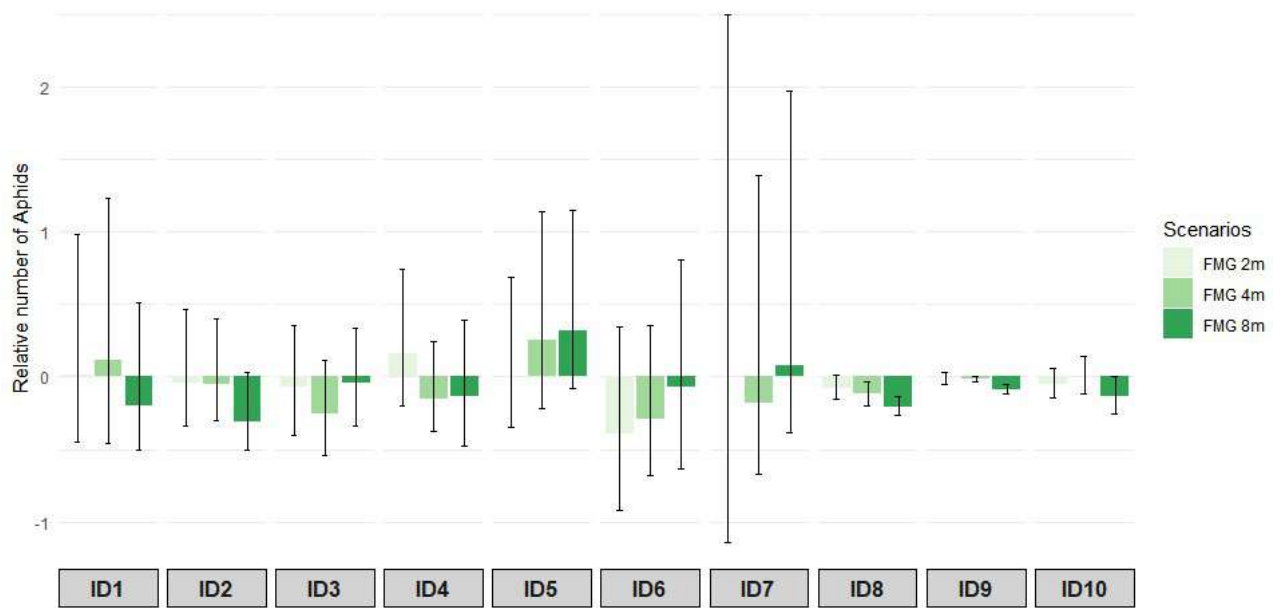


Figure 7.41 Grassy field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.3.3 In-field relative to landscape

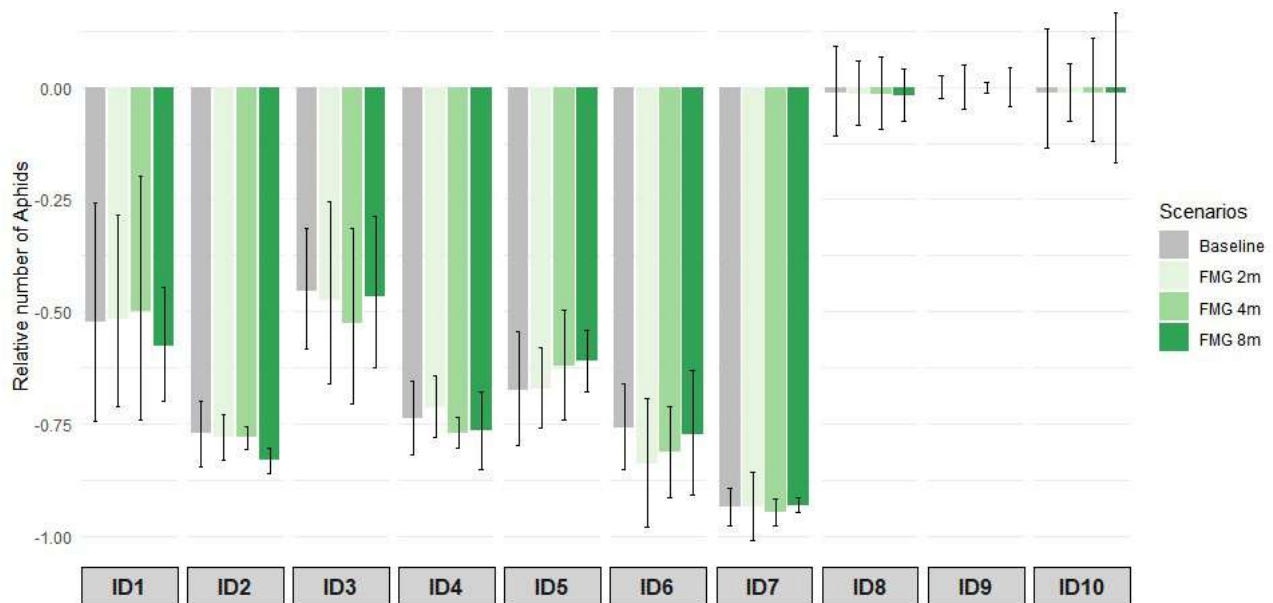


Figure 7.42 Grassy field margins scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.4 Mixed field margins

7.3.4.1 Whole landscape

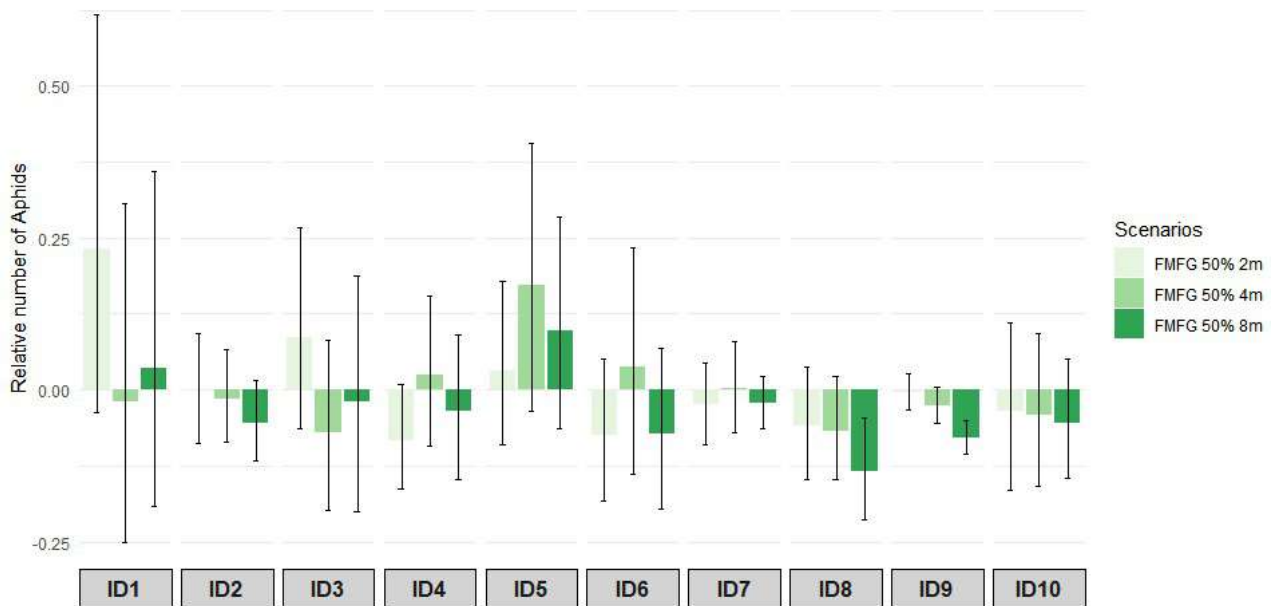


Figure 7.43 Mixed field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.4.2 In-field

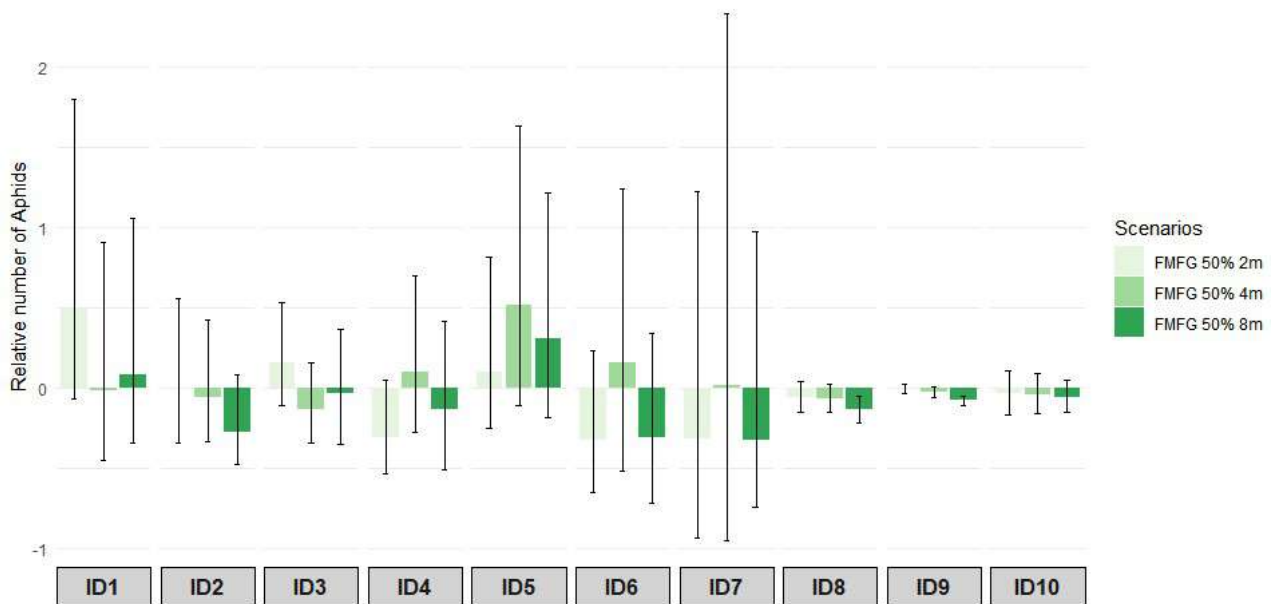


Figure 7.44 Mixed field margins scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.4.3 In-field relative to landscape

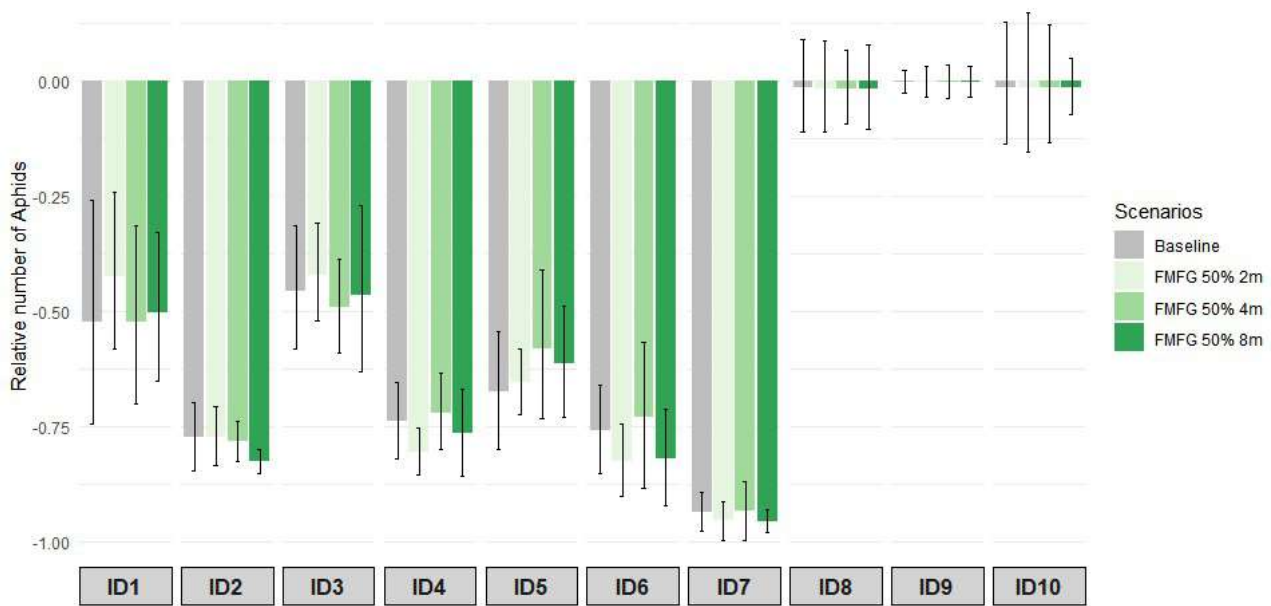


Figure 7.45 Mixed field margins scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.5 Flower, grassy and mixed margins

7.3.5.1 Whole landscape

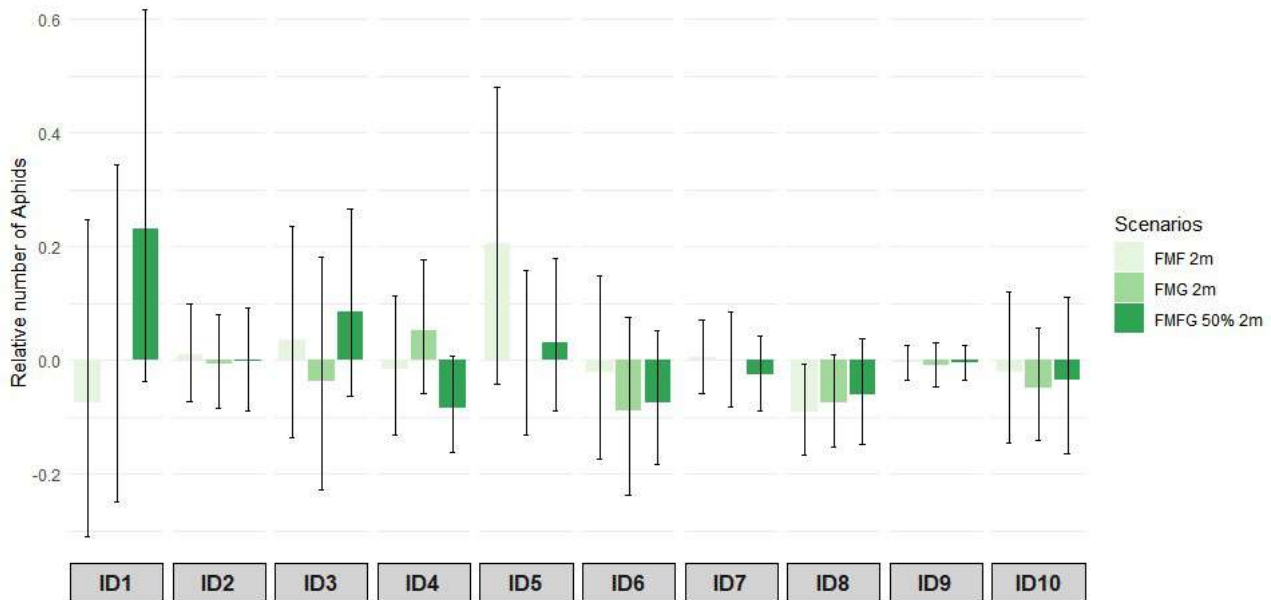


Figure 7.46 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

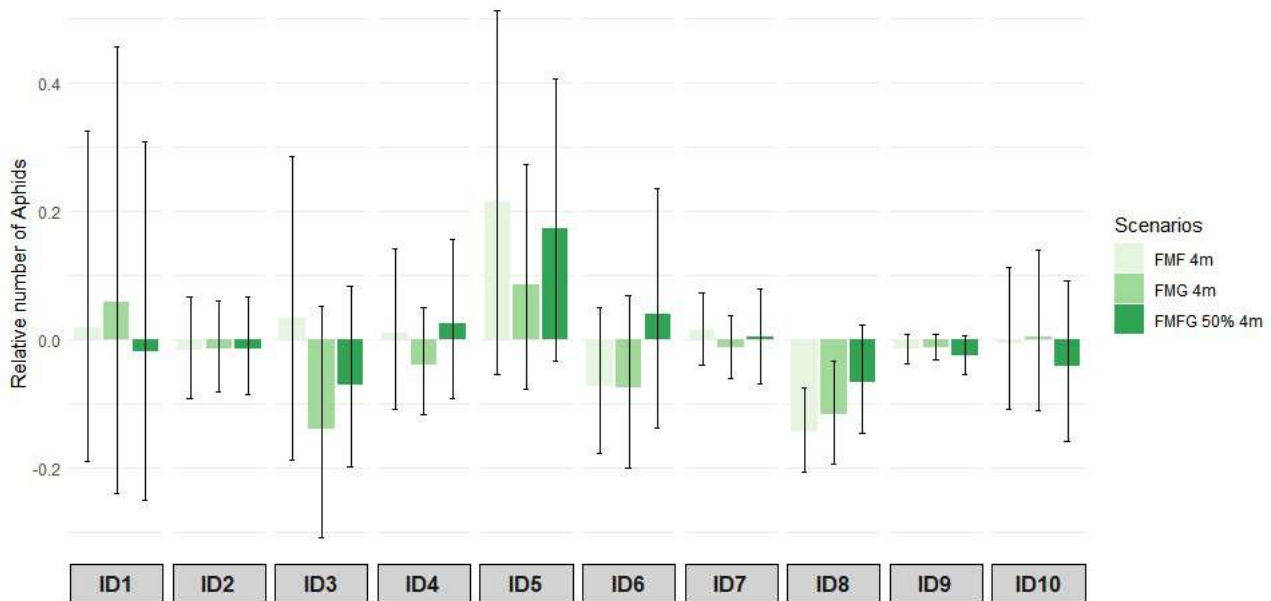


Figure 7.47 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

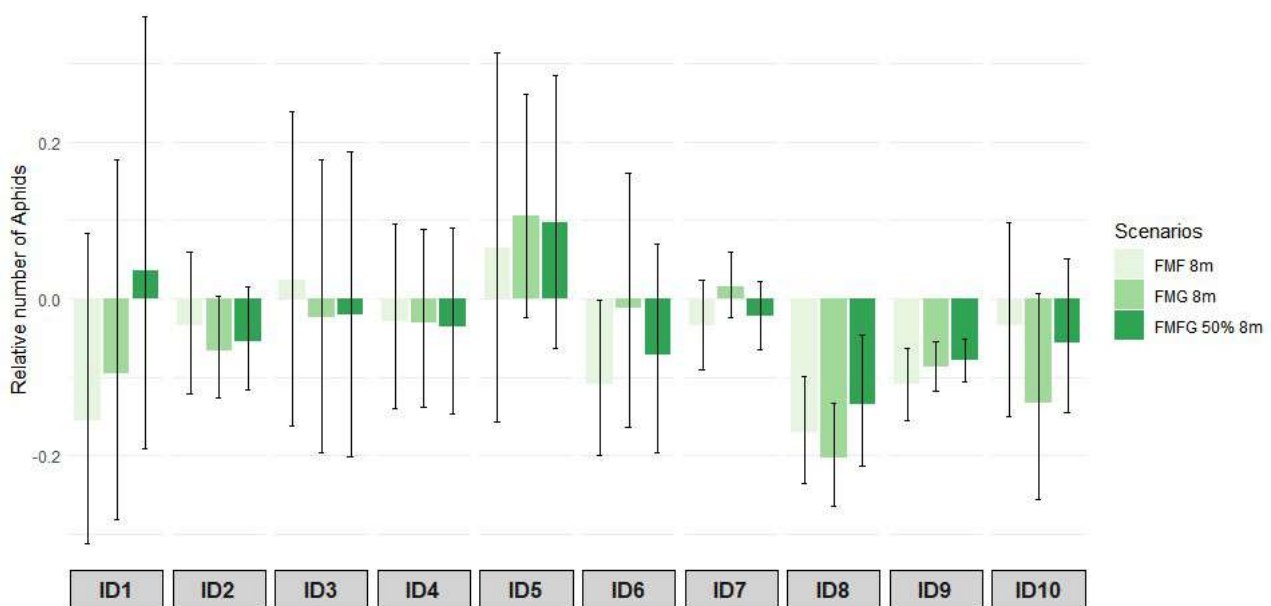


Figure 7.48 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.5.2 In-field

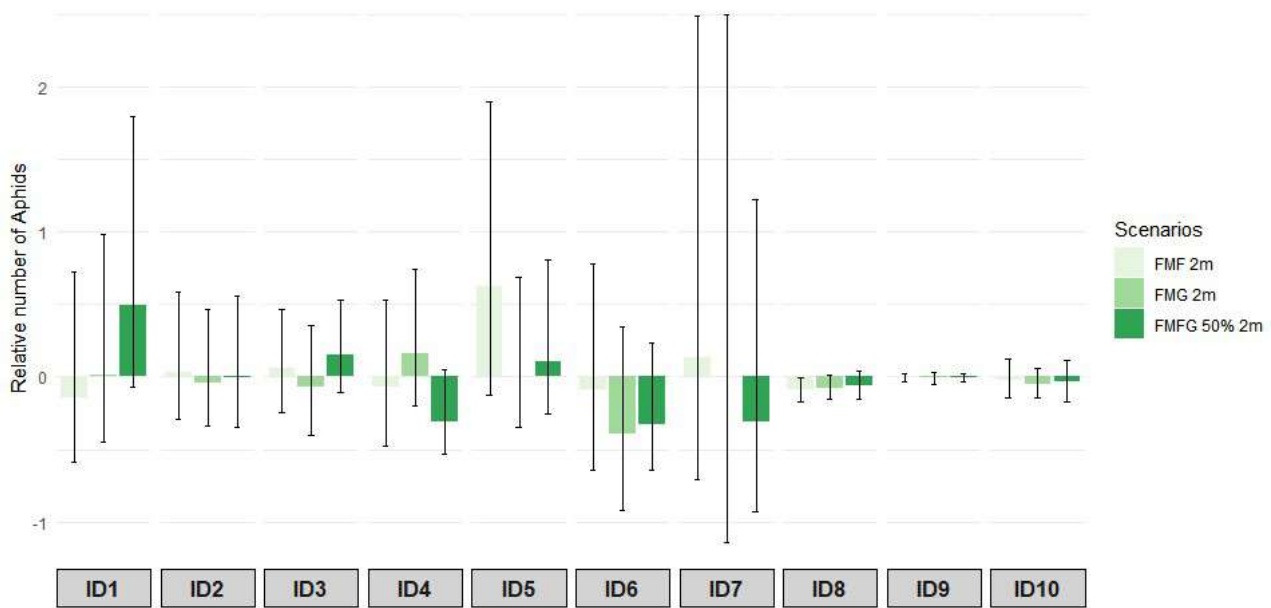


Figure 7.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

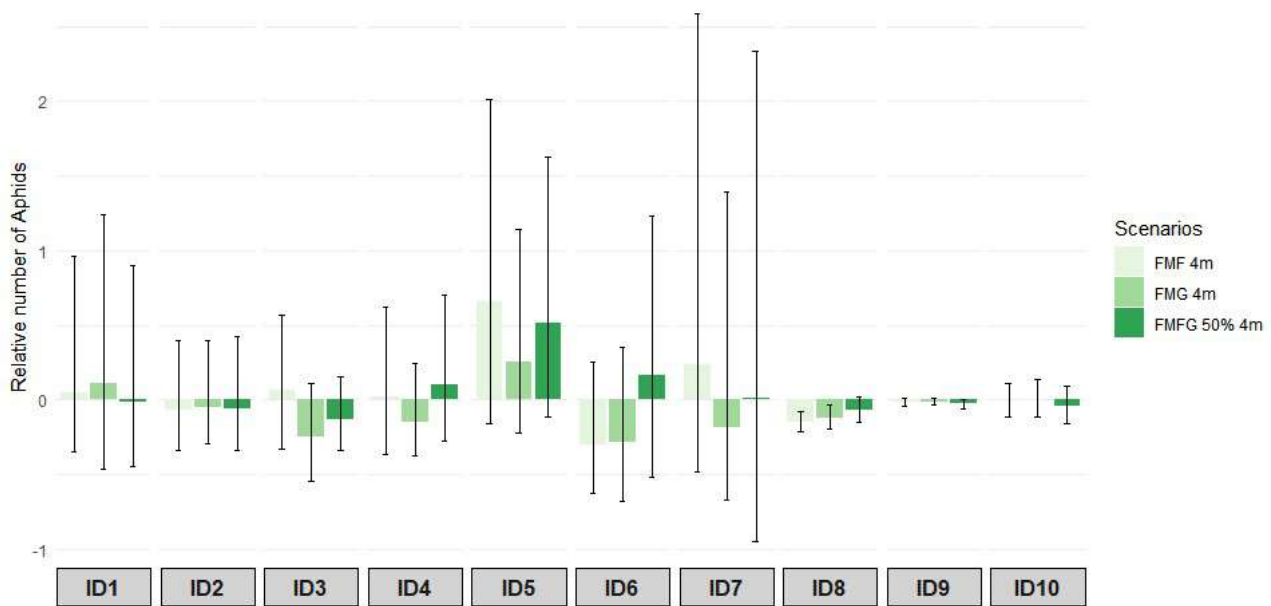


Figure 7.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

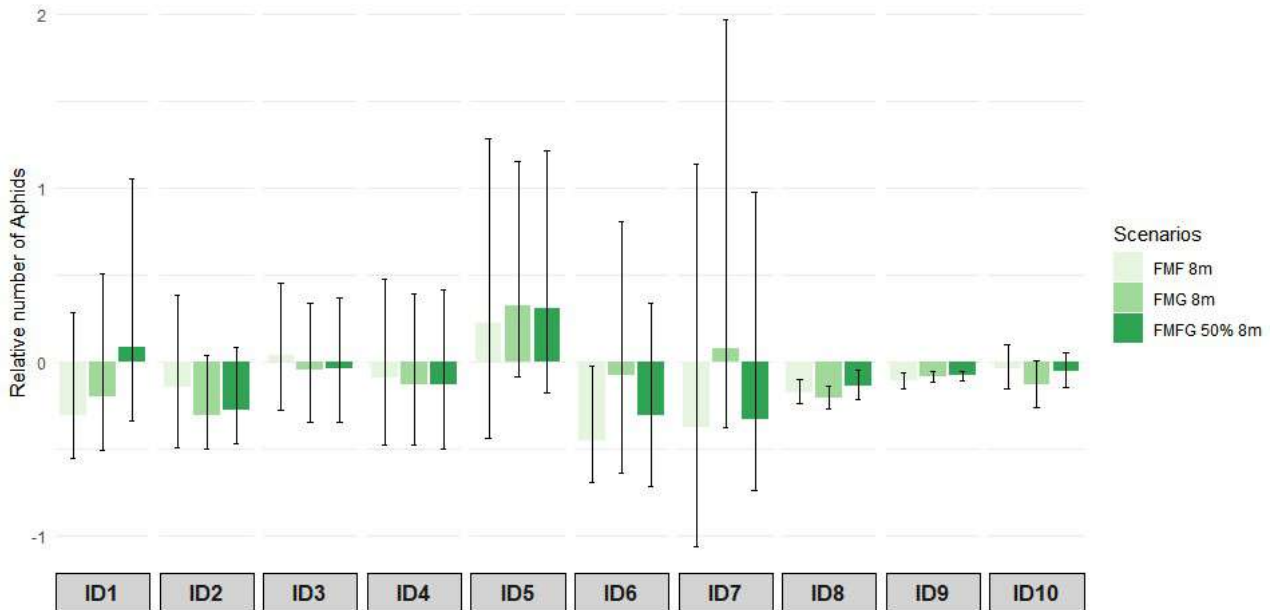


Figure 7.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.5.3 In-field relative to landscape

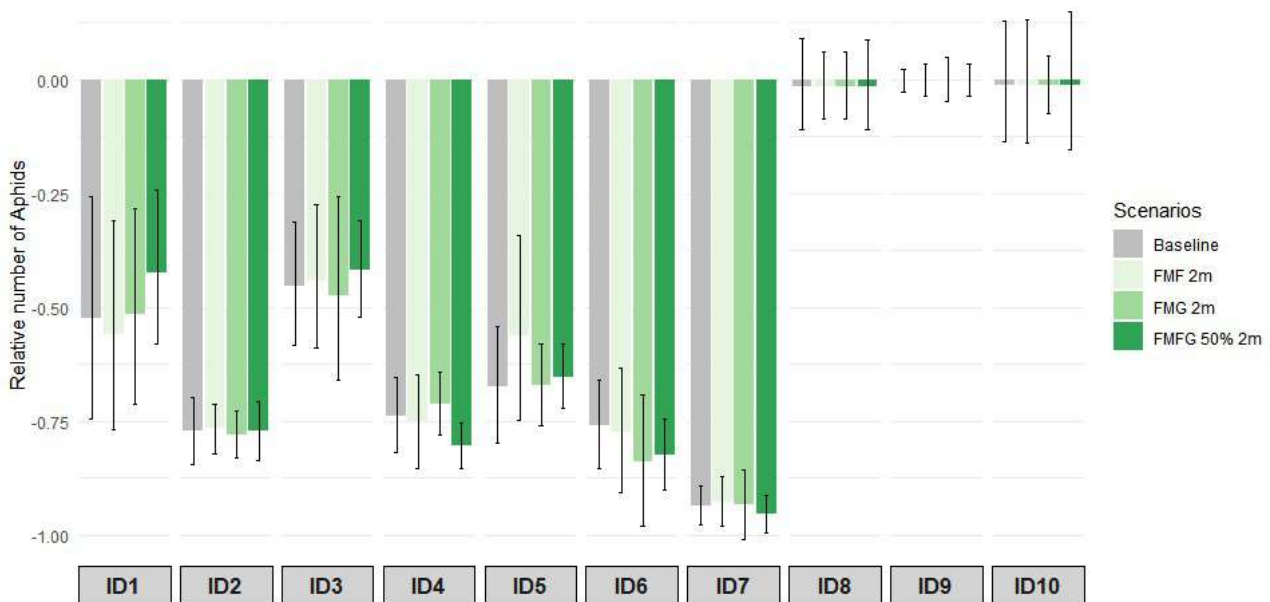


Figure 7.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

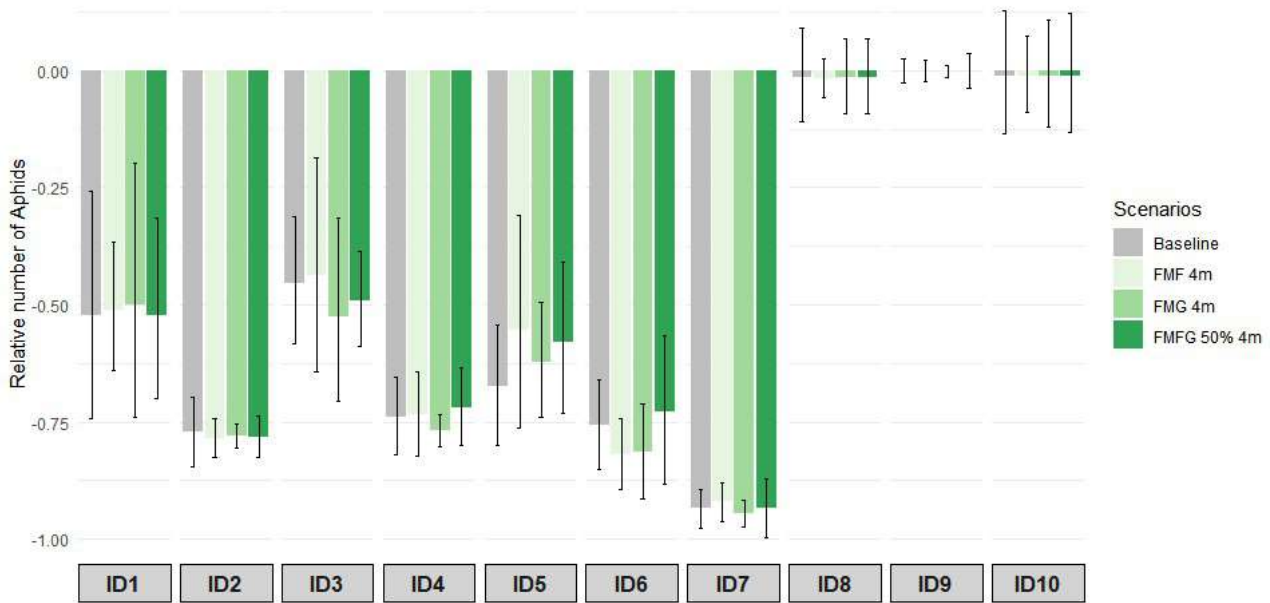


Figure 7.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

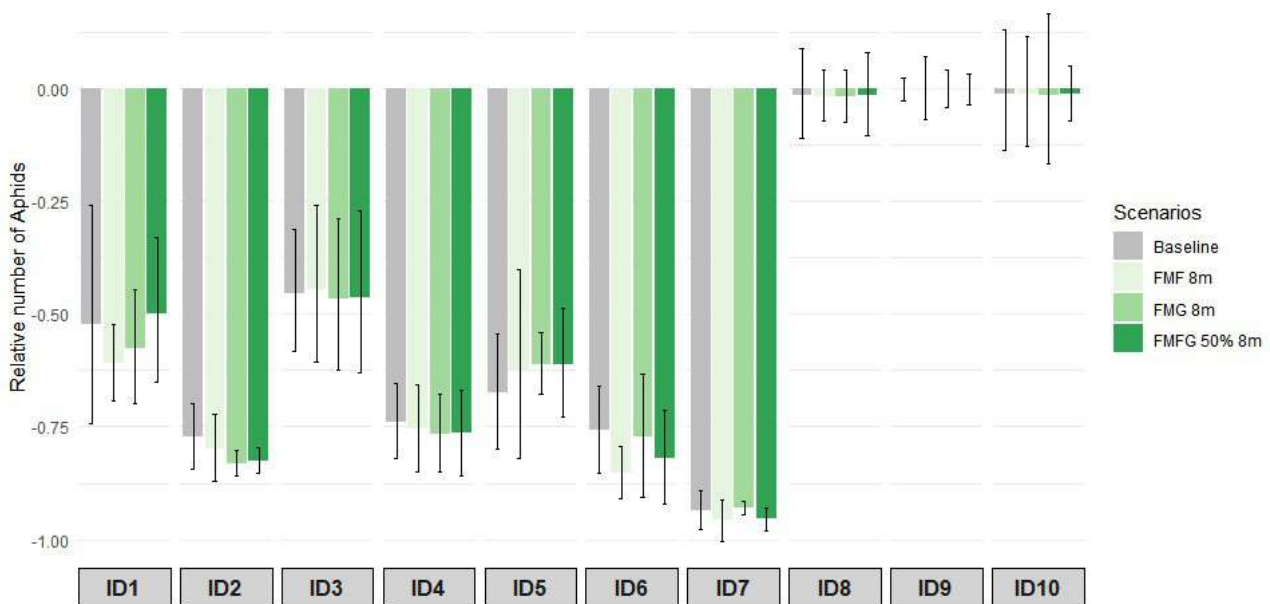


Figure 7.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.6 Setaside

7.3.6.1 Whole landscape

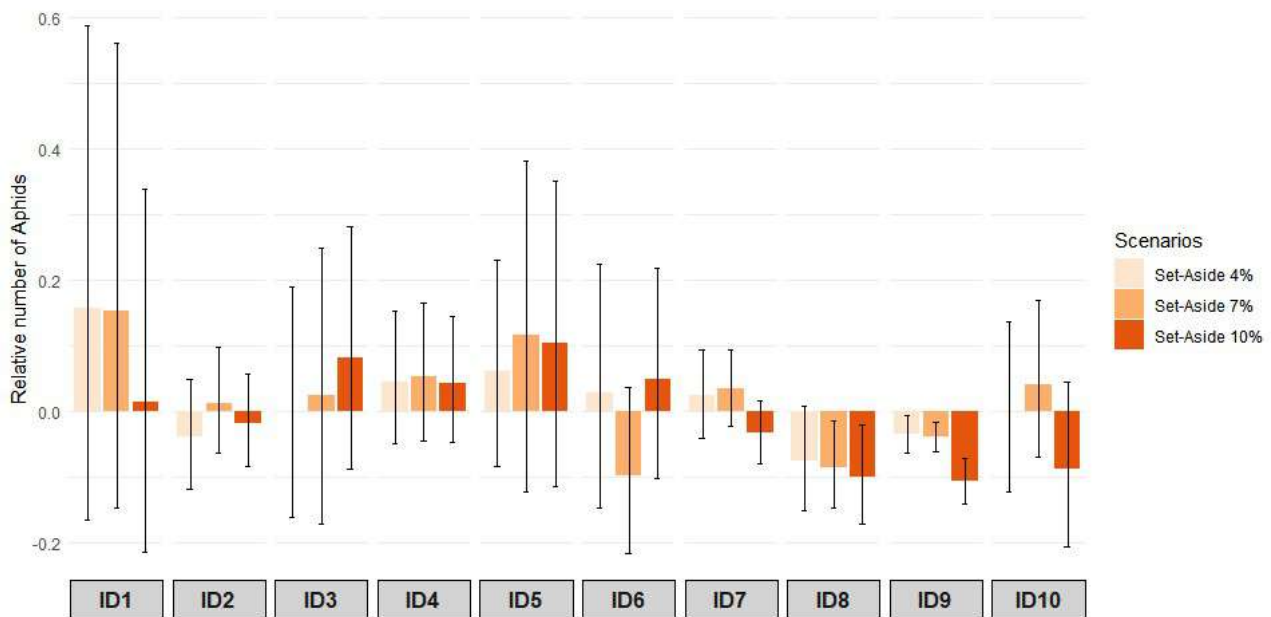


Figure 7.55 Setaside scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.6.2 In-field

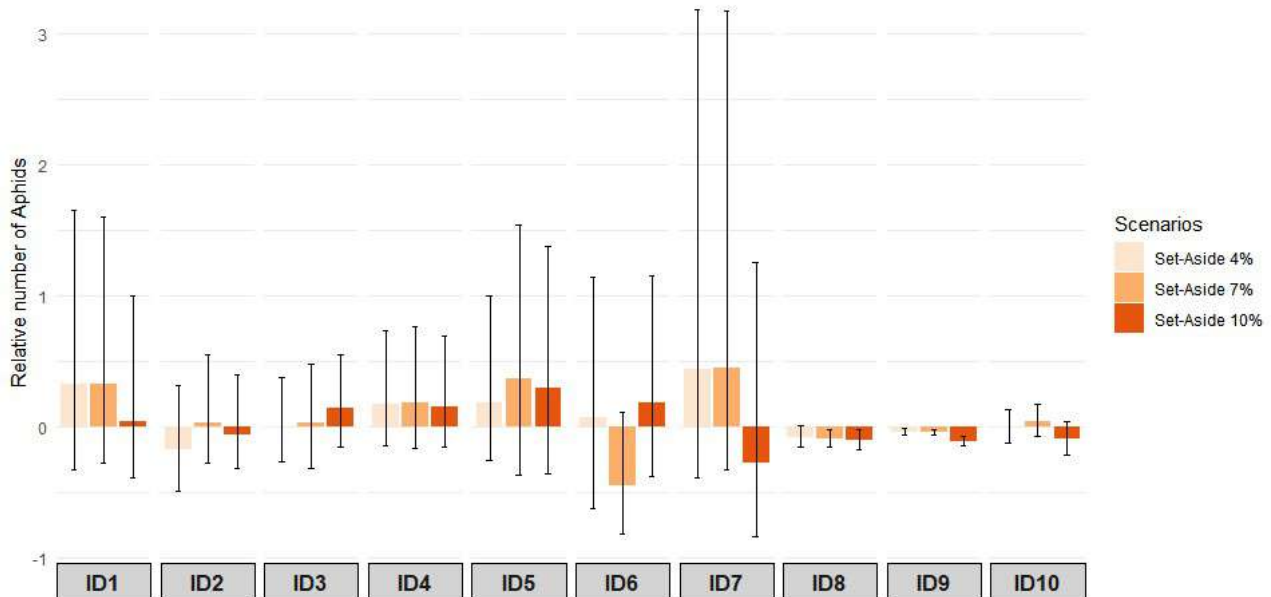


Figure 7.56 Setaside scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.6.3 In-field relative to landscape

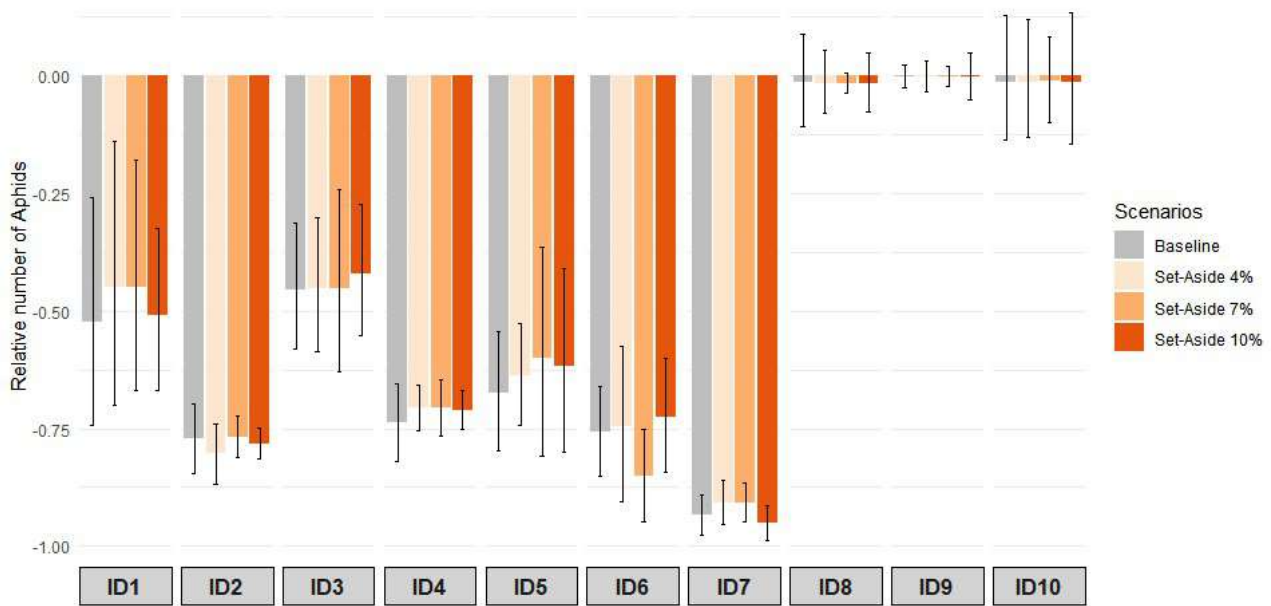


Figure 7.57 Setaside scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.7 Legume

7.3.7.1 Whole landscape

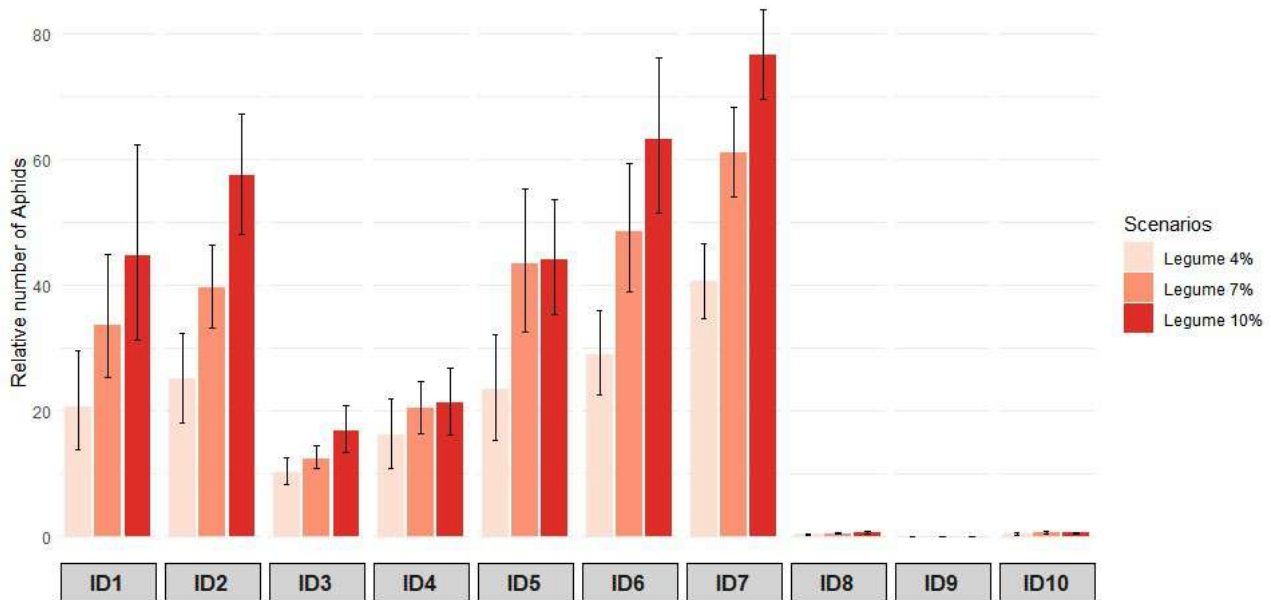


Figure 7.58 Legume scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.7.2 In-field

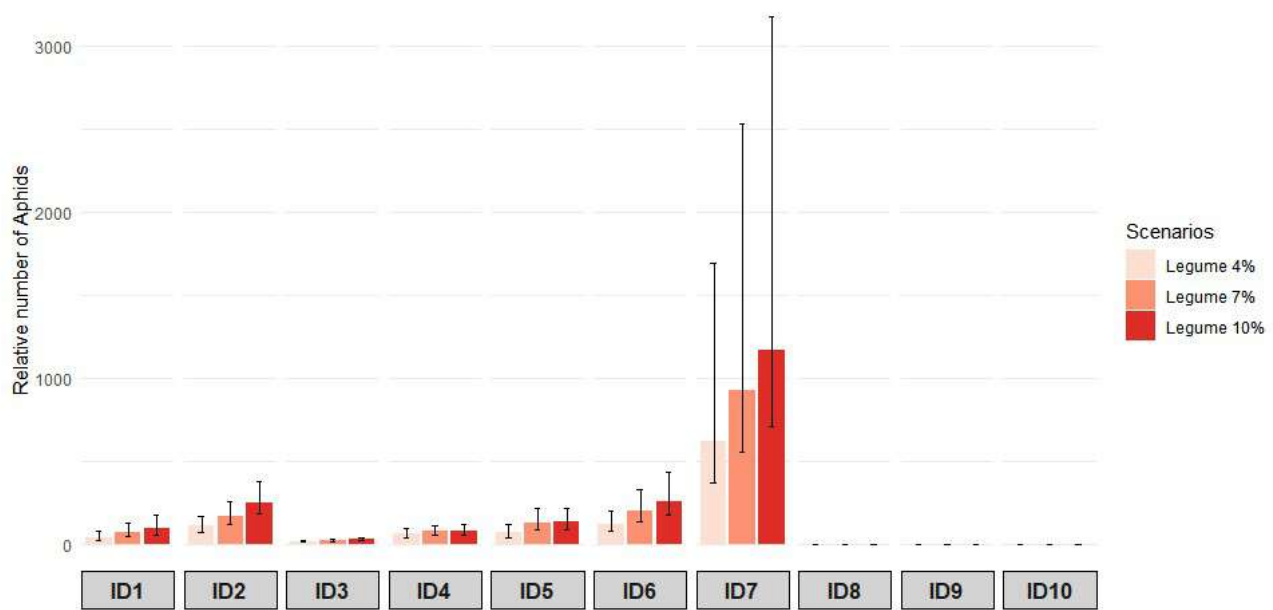


Figure 7.59 Legume scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.7.3 In-field relative to landscape

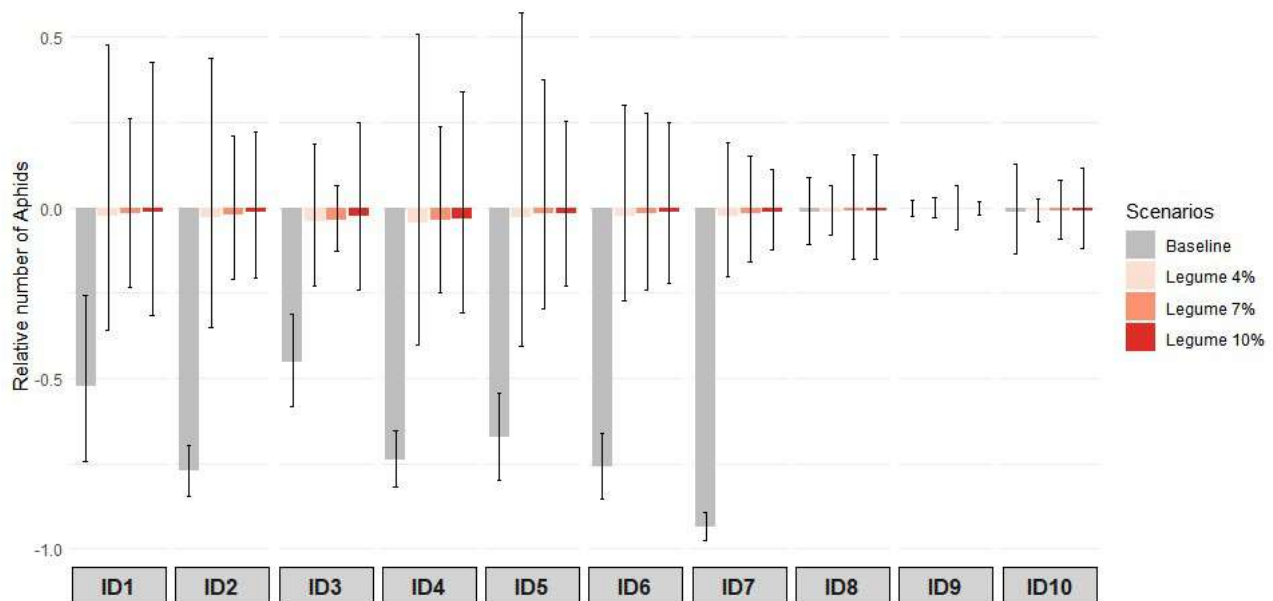


Figure 7.60 Legume scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.3.8 Biopesticides

7.3.8.1 Whole landscape

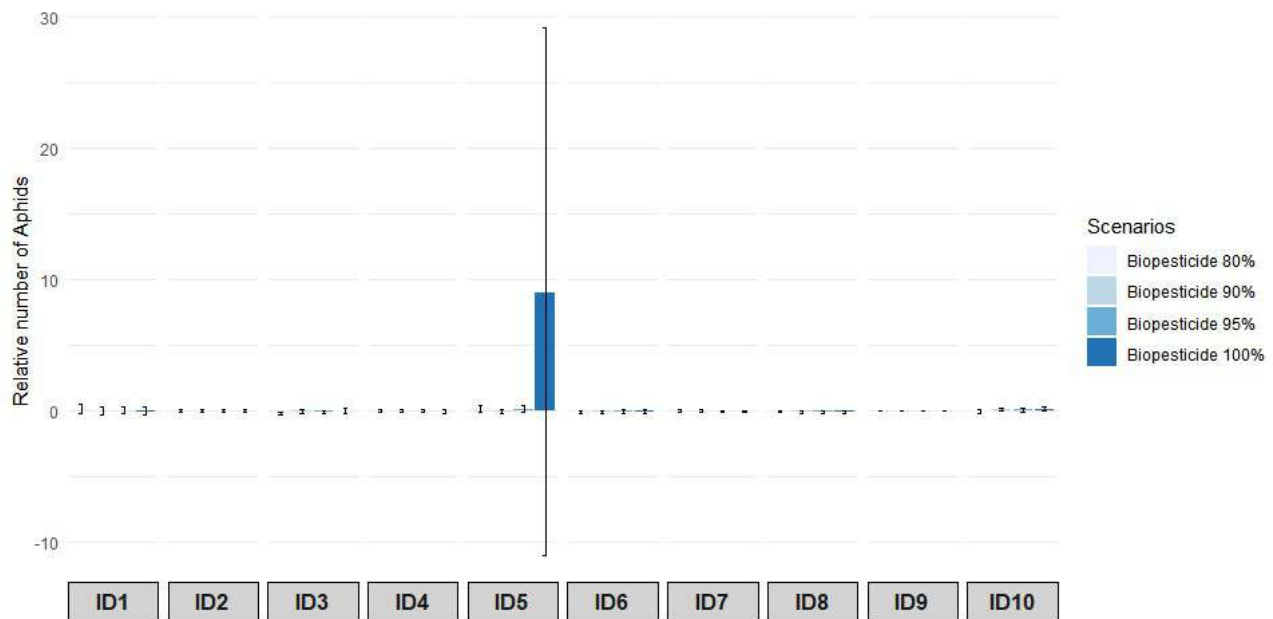


Figure 7.61 Biopesticide scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.3.8.2 In-field

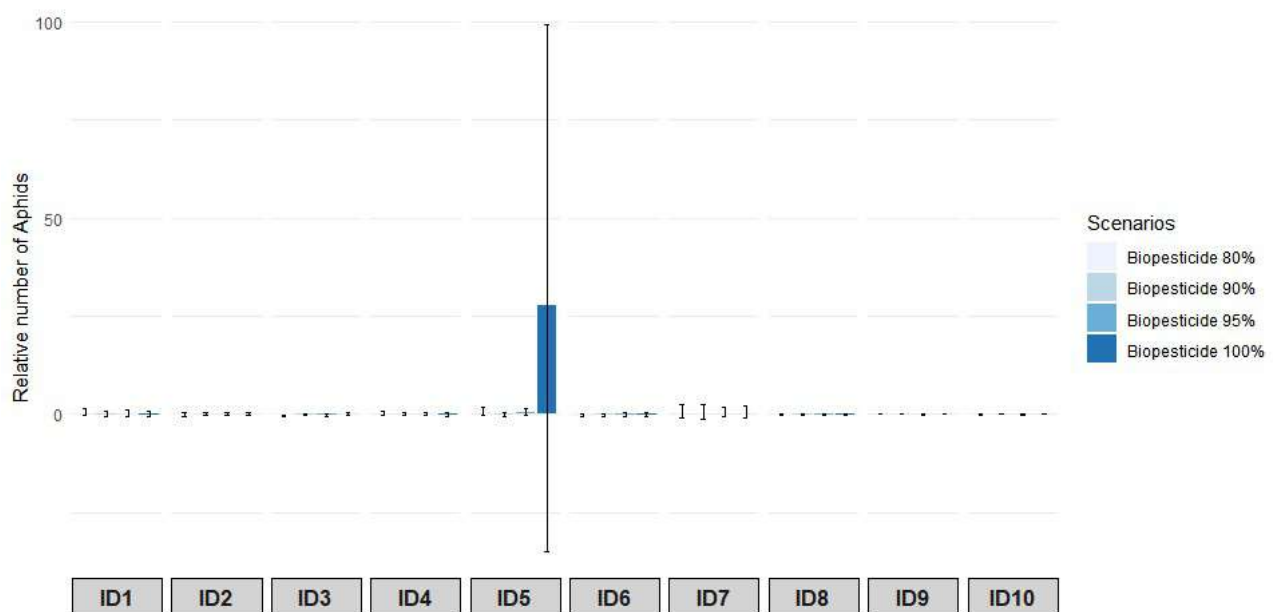


Figure 7.62 Biopesticide scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.3.8.3 In-field relative to landscape

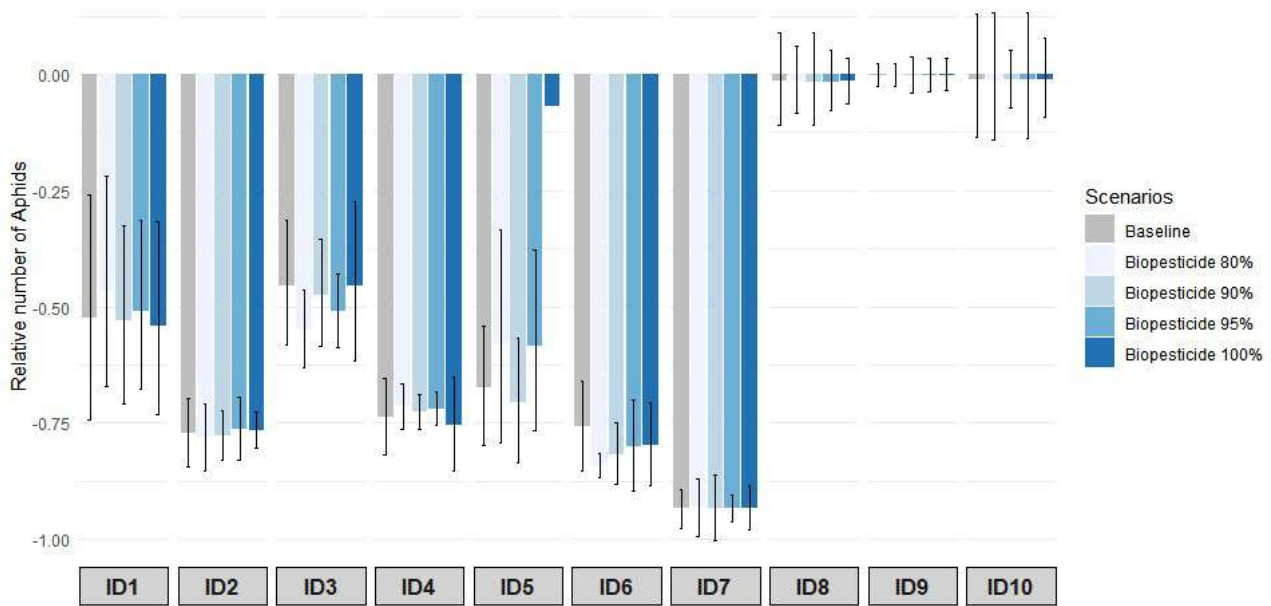


Figure 7.63 Biopesticide scenario with relative change in the number of female Black bean aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.4 Combined landscapes

7.4.1 Crop diversification

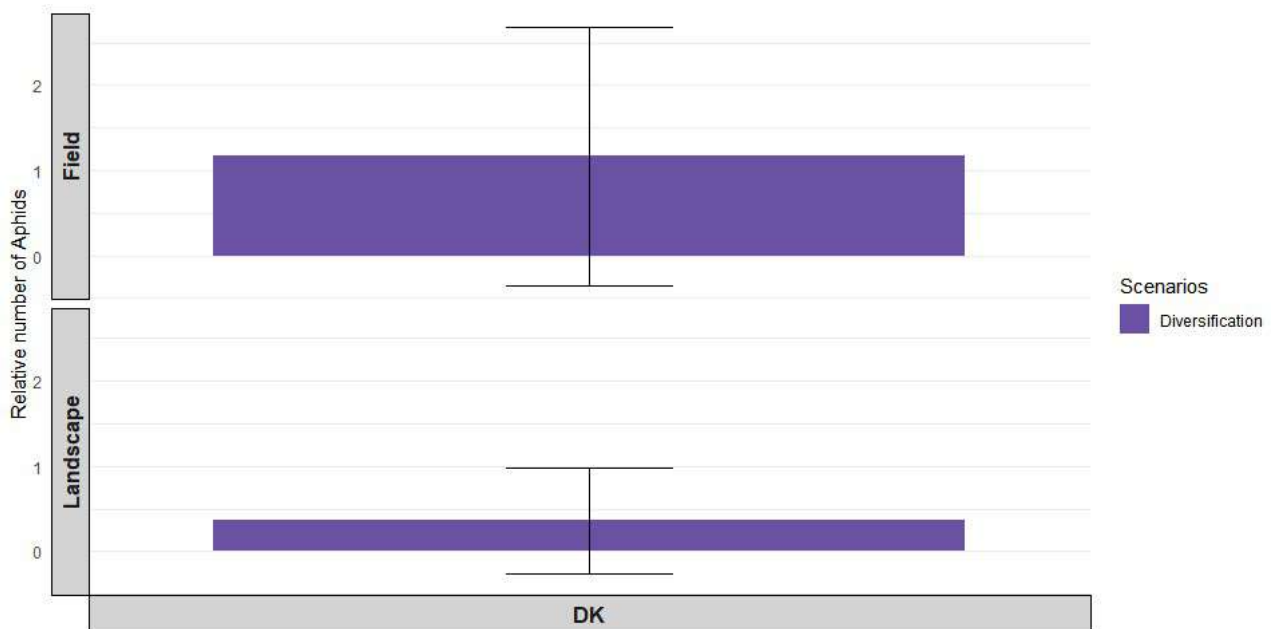


Figure 7.64 Diversification scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Denmark.

7.4.2 Flower field margins

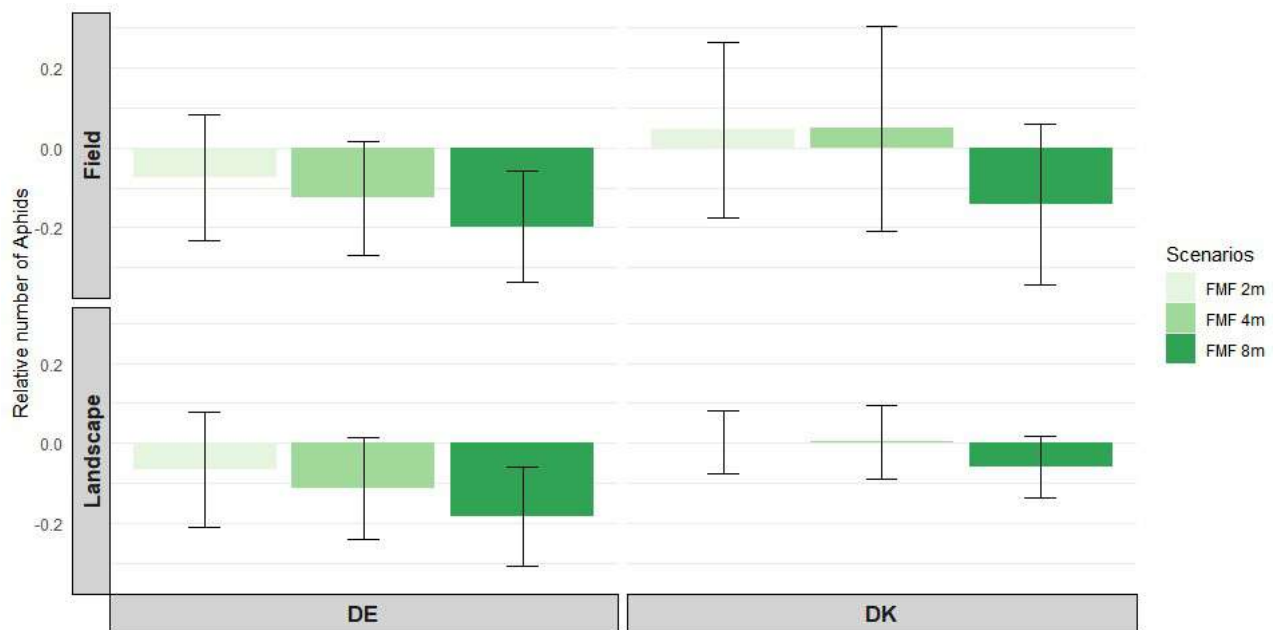


Figure 7.65 Flower field margins with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.3 Grass field margins

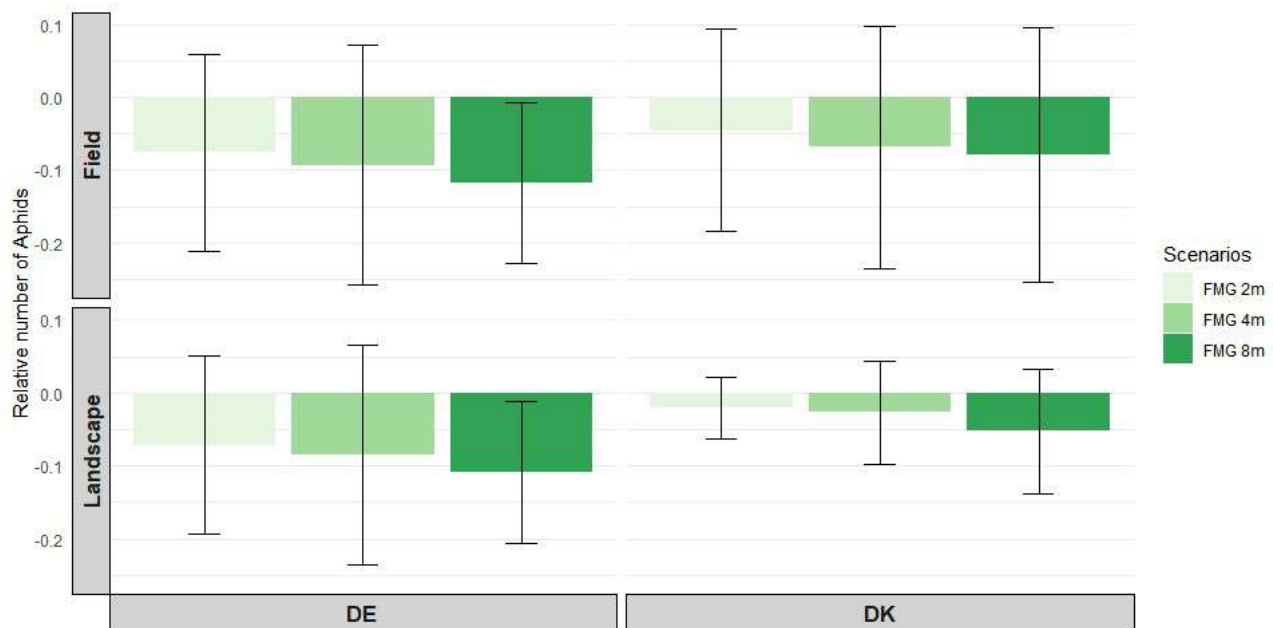


Figure 7.66 Grassy field margins with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.4 Mixed field margins

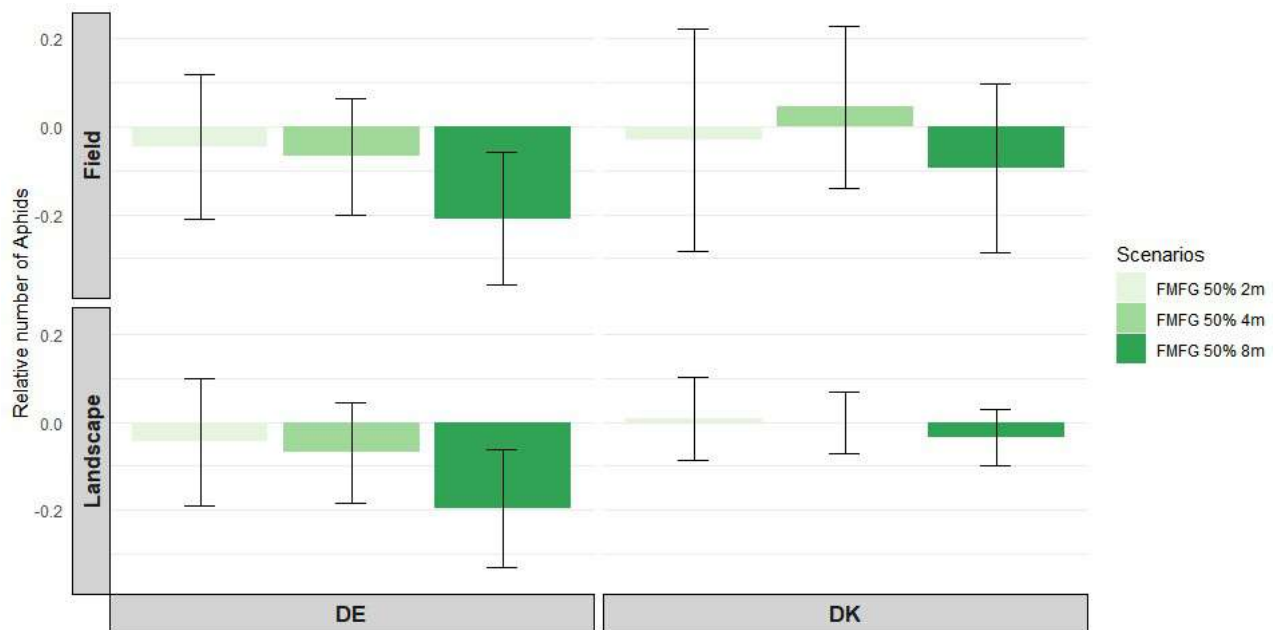


Figure 7.67 Mixed field margins with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.5 Flower, grassy and mixed margins

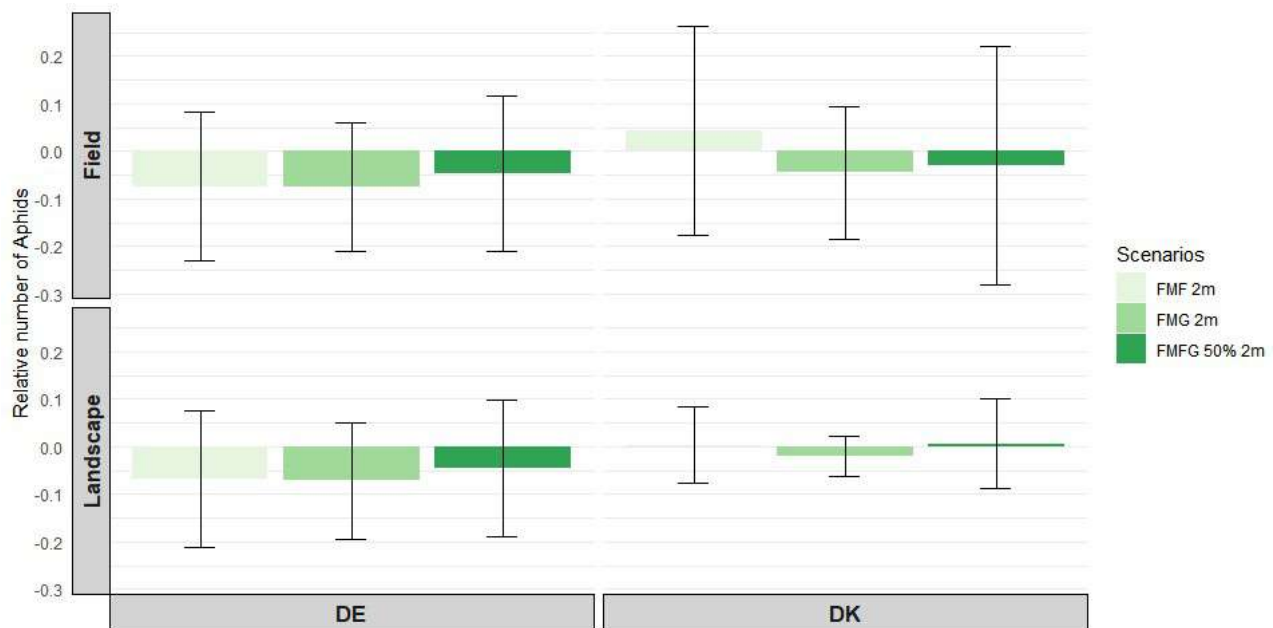


Figure 7.68 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

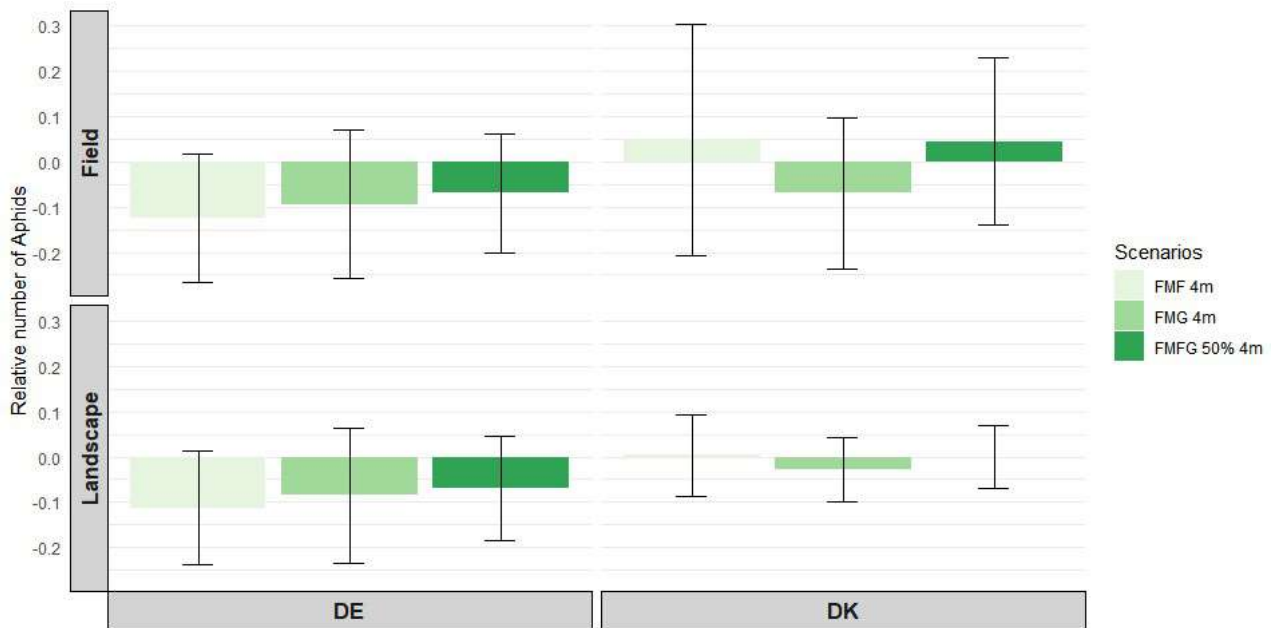


Figure 7.69 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

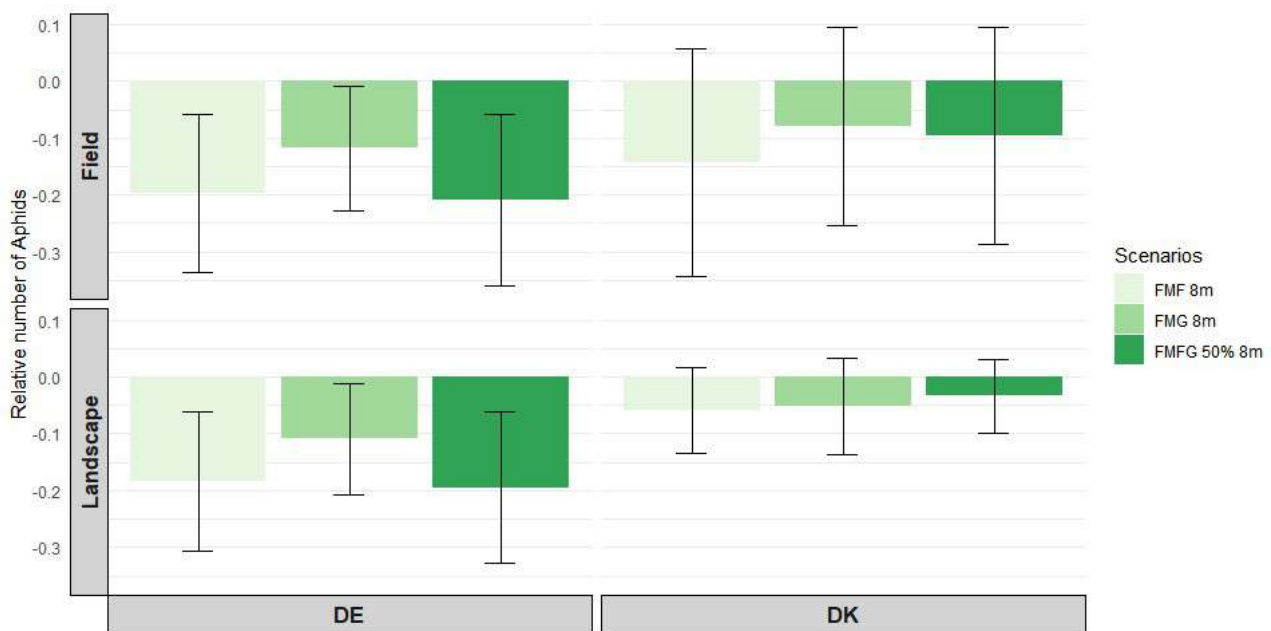


Figure 7.70 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.6 Setaside

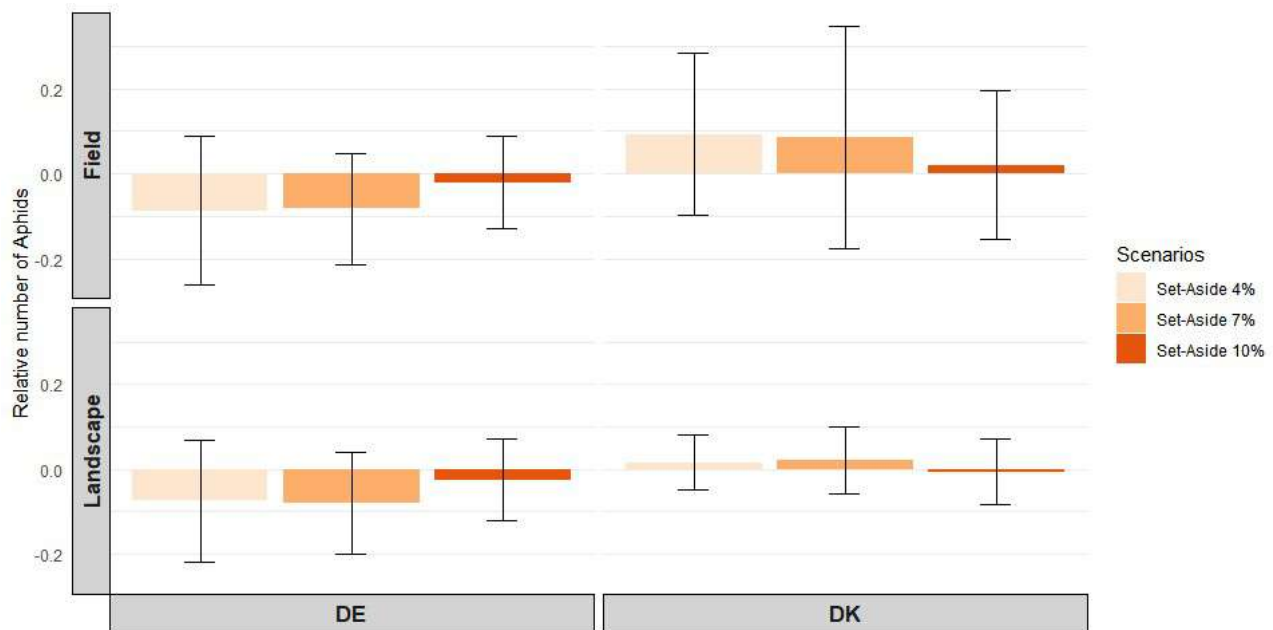


Figure 7.71 Setaside scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.7 Legume

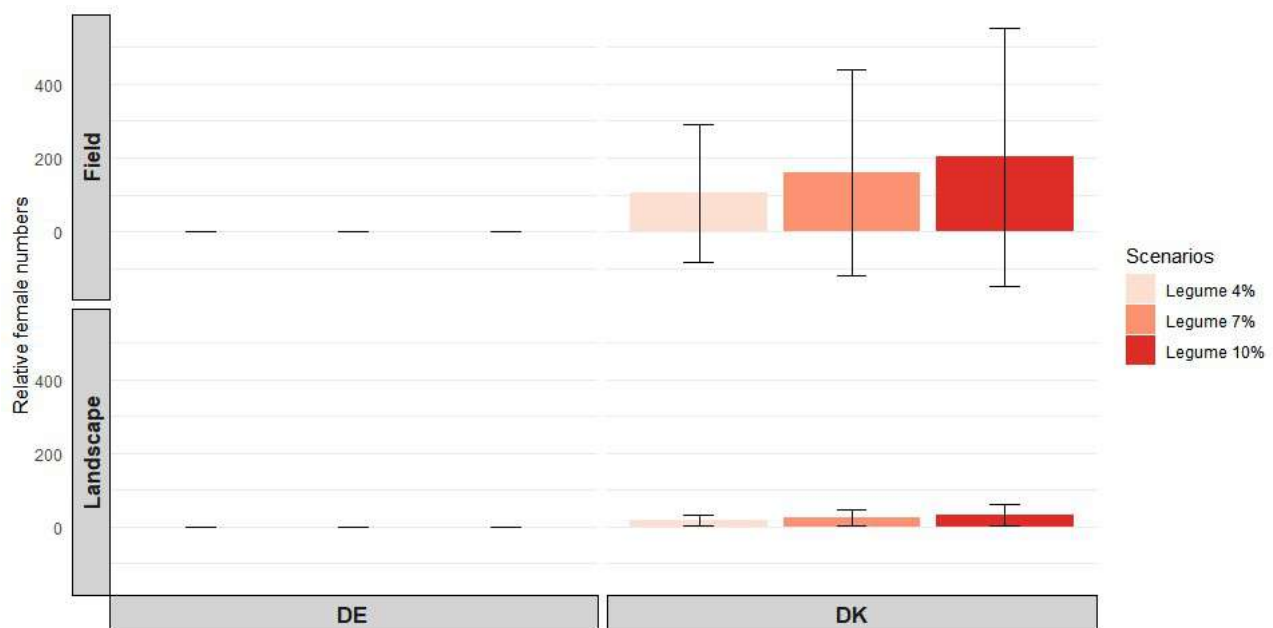


Figure 7.72 Legume scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.8 Biopesticides

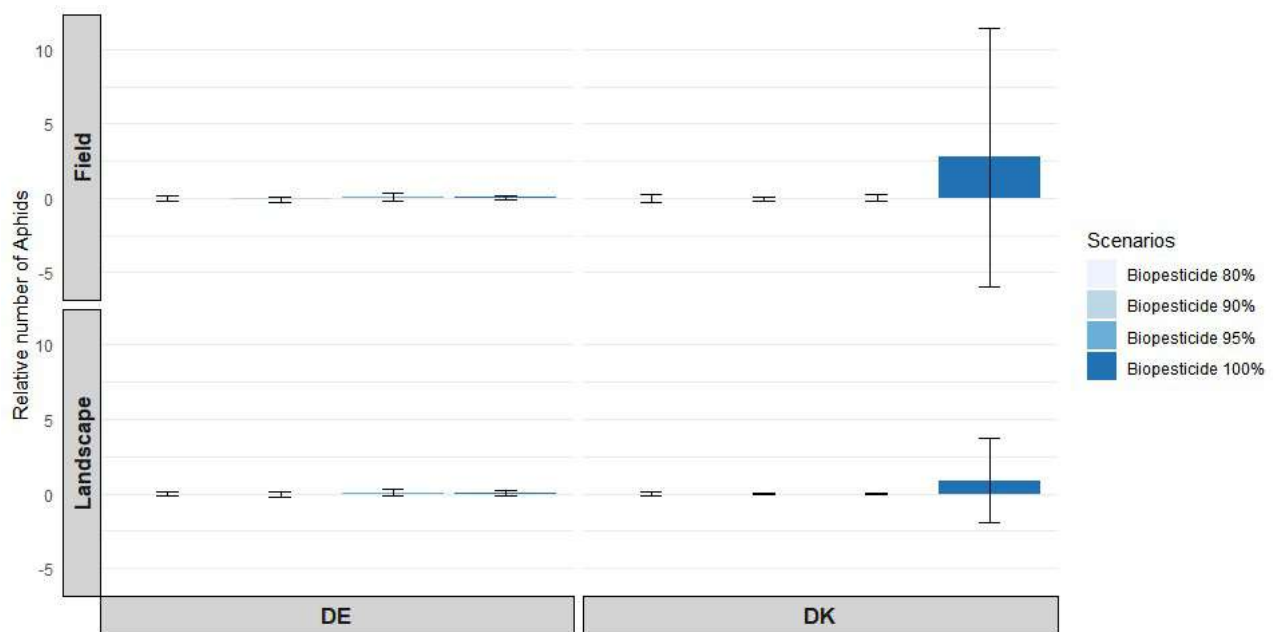


Figure 7.73 Biopesticide scenario with relative change in the number of female Black bean aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.4.9 Table: Country level overview of scenario effects

Table 7.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for Black bean aphids. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scale	Scenario	DK	DE
Field	Diversification	117% (SD 153%)	NA
Landscape	Diversification	36% (SD 62%)	NA
Field	FMF 2m	4% (SD 22%)	-7% (SD 16%)
Field	FMF 4m	5% (SD 26%)	-13% (SD 14%)
Field	FMF 8m	-14% (SD 20%)	-20% (SD 14%)
Landscape	FMF 2m	0% (SD 8%)	-7% (SD 14%)
Landscape	FMF 4m	0% (SD 9%)	-11% (SD 13%)
Landscape	FMF 8m	-6% (SD 8%)	-18% (SD 12%)
Field	FMG 2m	-5% (SD 14%)	-8% (SD 14%)
Field	FMG 4m	-7% (SD 17%)	-9% (SD 16%)
Field	FMG 8m	-8% (SD 17%)	-12% (SD 11%)
Landscape	FMG 2m	-2% (SD 4%)	-7% (SD 12%)

Scale	Scenario	DK	DE
Landscape	FMG 4m	-3% (SD 7%)	-9% (SD 15%)
Landscape	FMG 8m	-5% (SD 8%)	-11% (SD 10%)
Field	FMFG 50% 2m	-3% (SD 25%)	-5% (SD 16%)
Field	FMFG 50% 4m	4% (SD 18%)	-7% (SD 13%)
Field	FMFG 50% 8m	-10% (SD 19%)	-21% (SD 15%)
Landscape	FMFG 50% 2m	1% (SD 9%)	-5% (SD 14%)
Landscape	FMFG 50% 4m	-0% (SD 7%)	-7% (SD 11%)
Landscape	FMFG 50% 8m	-3% (SD 6%)	-20% (SD 13%)
Field	Set-Aside 4%	9% (SD 19%)	-9% (SD 18%)
Field	Set-Aside 7%	9% (SD 26%)	-8% (SD 13%)
Field	Set-Aside 10%	2% (SD 18%)	-2% (SD 11%)
Landscape	Set-Aside 4%	2% (SD 6%)	-7% (SD 14%)
Landscape	Set-Aside 7%	2% (SD 8%)	-8% (SD 12%)
Landscape	Set-Aside 10%	-1% (SD 8%)	-2% (SD 10%)
Field	Legume 4%	10430% (SD 18552%)	-5% (SD 19%)
Field	Legume 7%	16060% (SD 27913%)	-7% (SD 14%)
Field	Legume 10%	20199% (SD 35210%)	-4% (SD 19%)
Landscape	Legume 4%	1658% (SD 1378%)	-4% (SD 17%)
Landscape	Legume 7%	2597% (SD 2230%)	-7% (SD 13%)
Landscape	Legume 10%	3251% (SD 2843%)	-4% (SD 16%)
Field	Biopesticide 80%	1% (SD 26%)	-0% (SD 17%)
Field	Biopesticide 90%	-5% (SD 11%)	-7% (SD 18%)
Field	Biopesticide 95%	3% (SD 19%)	9% (SD 26%)
Field	Biopesticide 100%	274% (SD 873%)	6% (SD 15%)
Landscape	Biopesticide 80%	-0% (SD 10%)	-1% (SD 15%)
Landscape	Biopesticide 90%	-2% (SD 5%)	-6% (SD 17%)
Landscape	Biopesticide 95%	0% (SD 8%)	8% (SD 22%)
Landscape	Biopesticide 100%	90% (SD 284%)	5% (SD 14%)

7.B ENGLISH GRAIN APHID

7.5 Baselines across countries

7.5.1 Whole landscape

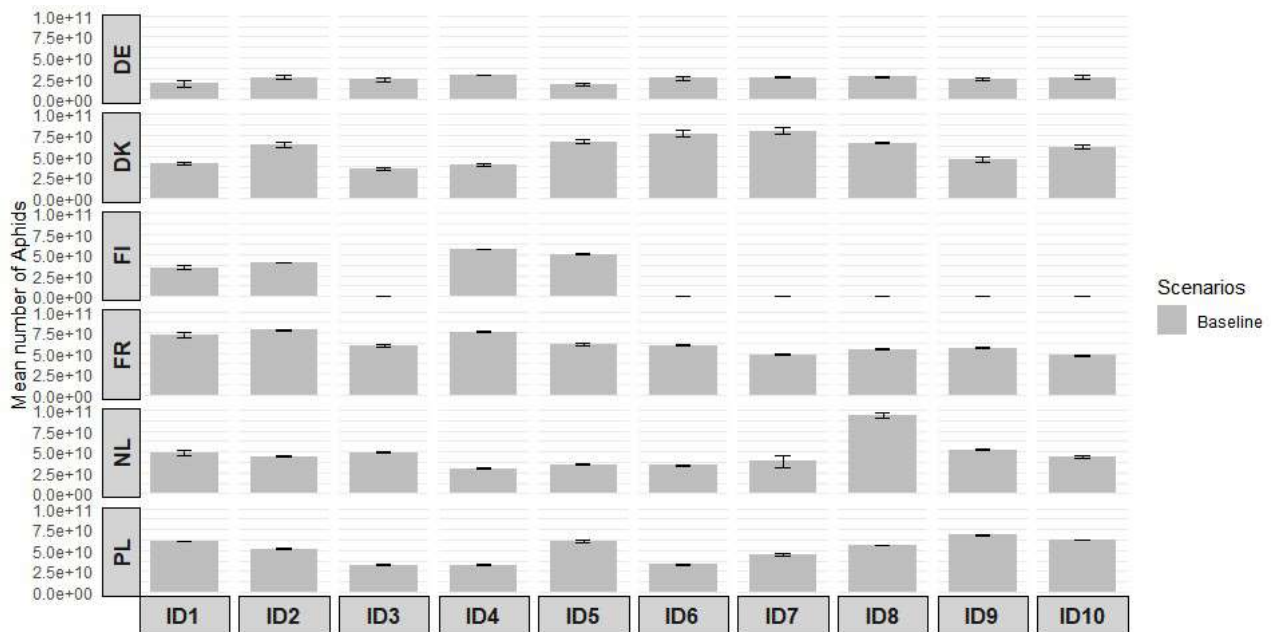


Figure 7.74 English grain aphid baselines for each country and landscape.

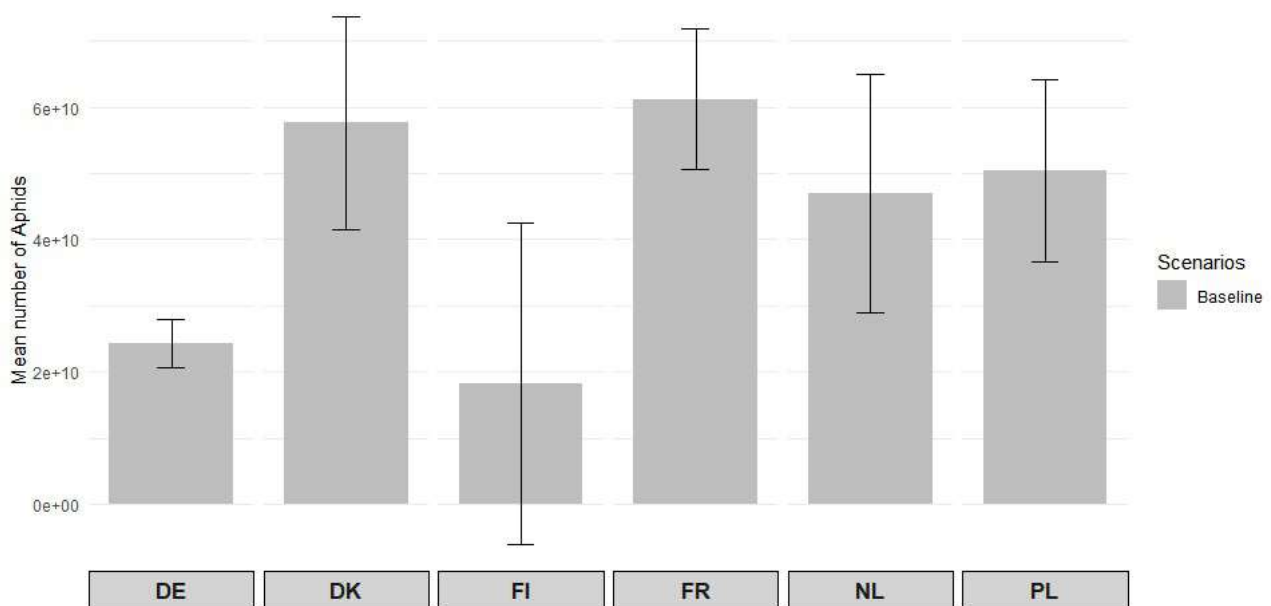


Figure 7.75 English grain aphid baselines for each country combined across landscapes.

7.5.2 In-field

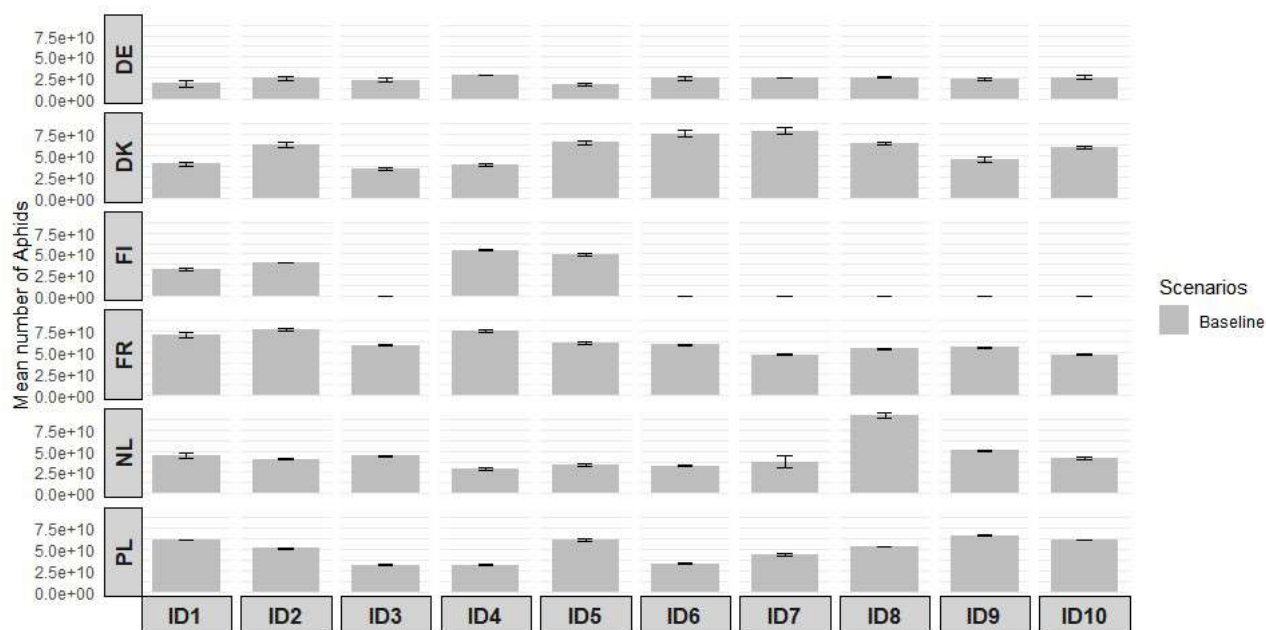


Figure 7.76 English grain aphid baselines for each country and landscape. English grain aphids in the fields only.

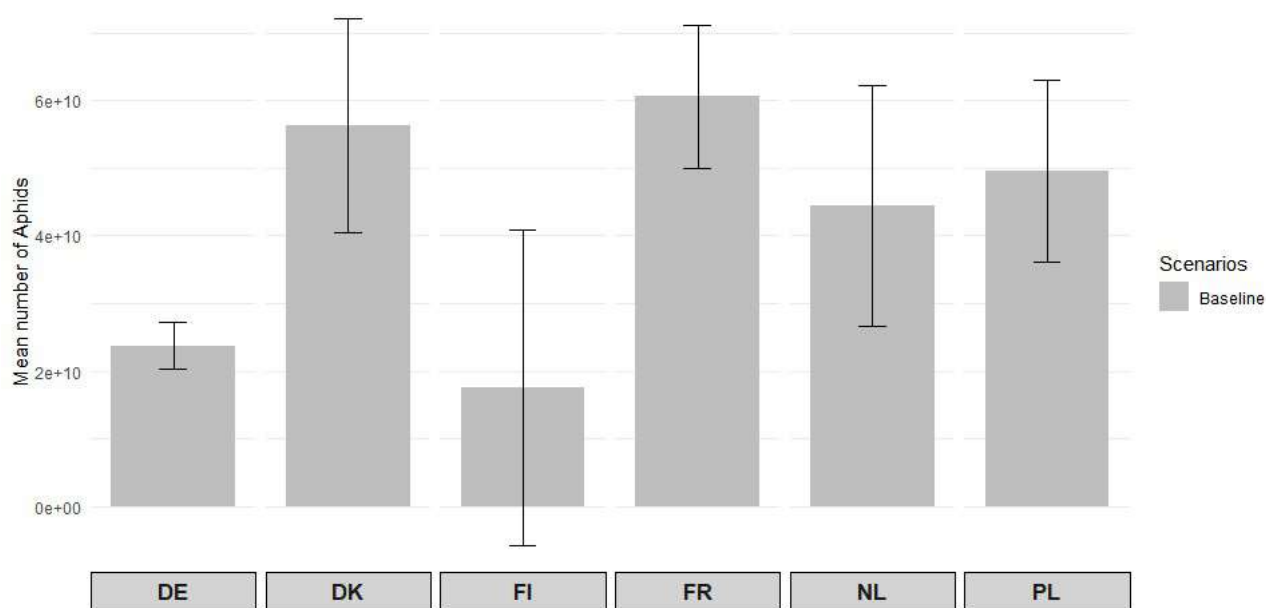


Figure 7.77 English grain aphid baselines for each country combined across landscapes. English grain aphids in the fields only.

7.5.3 In-field relative to landscape

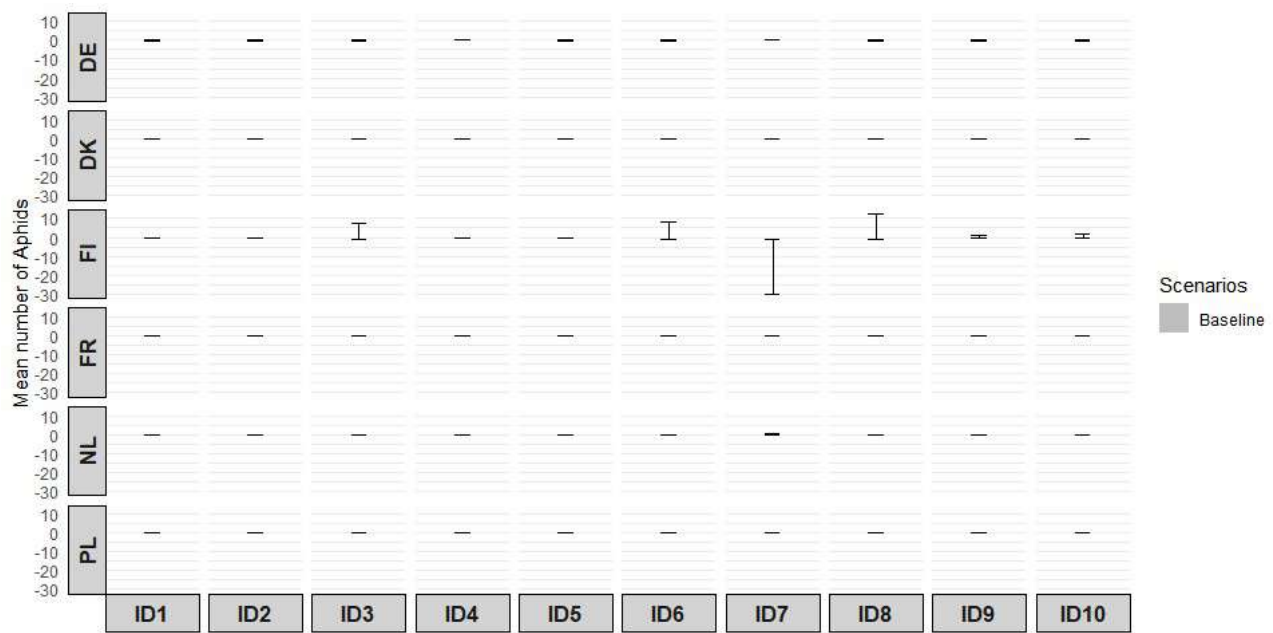


Figure 7.77 In-field relative to whole landscape comparison of English grain aphid baseline runs across countries and landscapes.

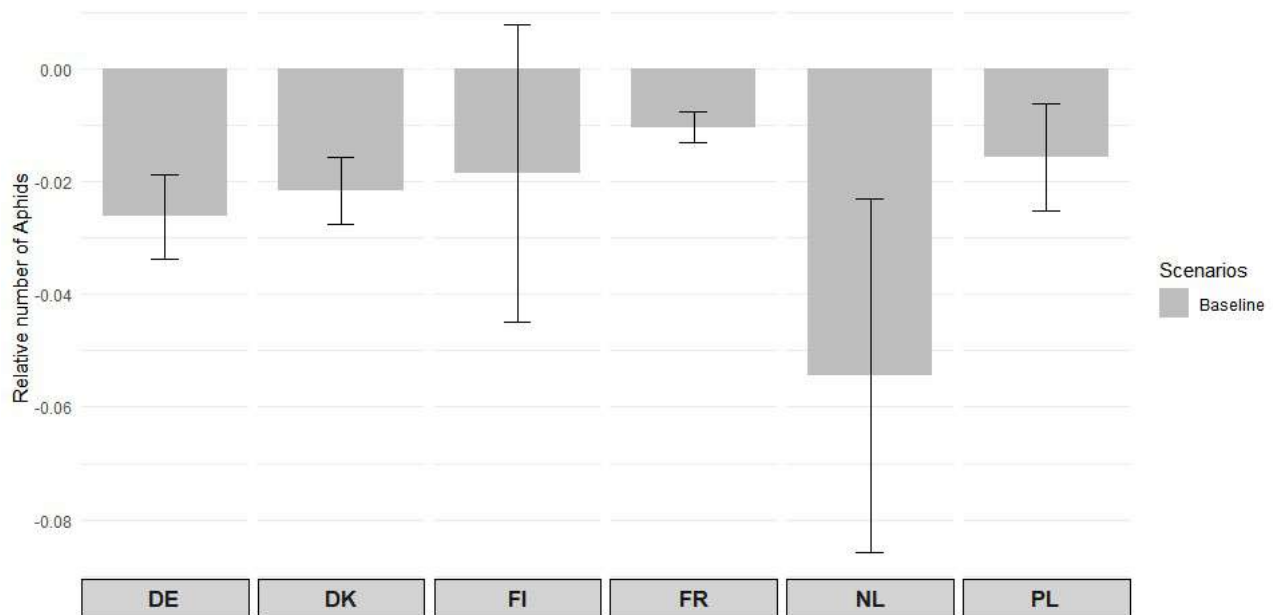


Figure 7.78 In-field relative to whole landscape comparison of English grain aphid baseline for each country across landscapes.

7.6 Germany

7.6.1 Flower field margins

7.6.1.1 Whole landscape

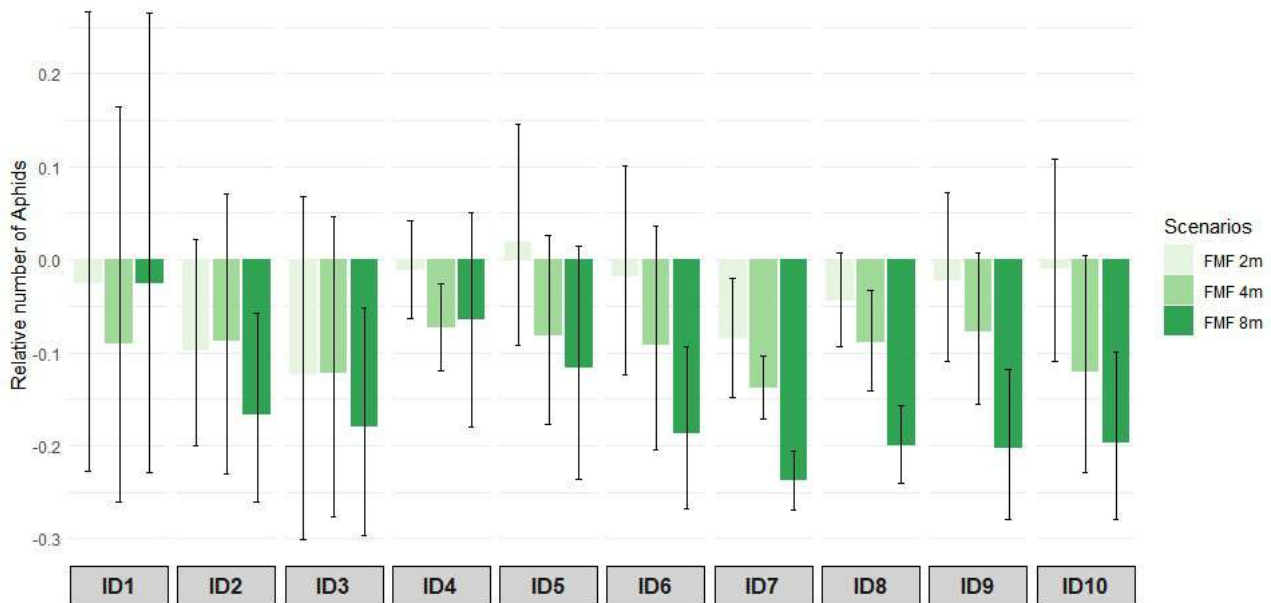


Figure 7.79 Flower field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.1.2 In-field

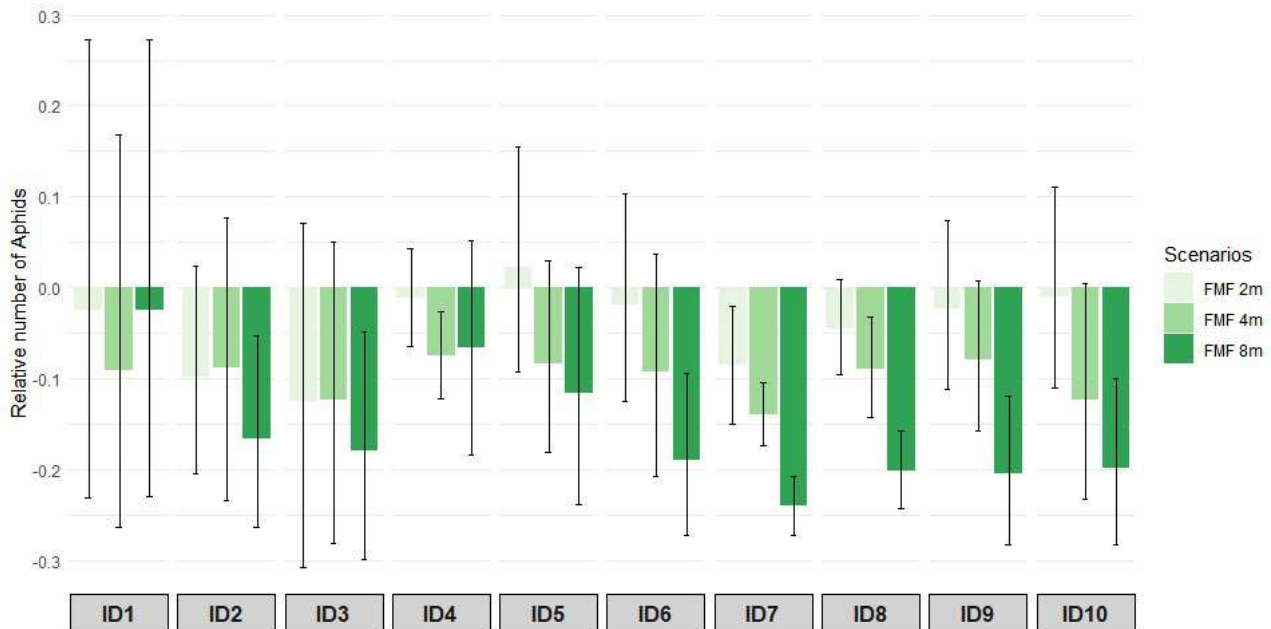


Figure 7.80 Flower field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.1.3 In-field relative to landscape

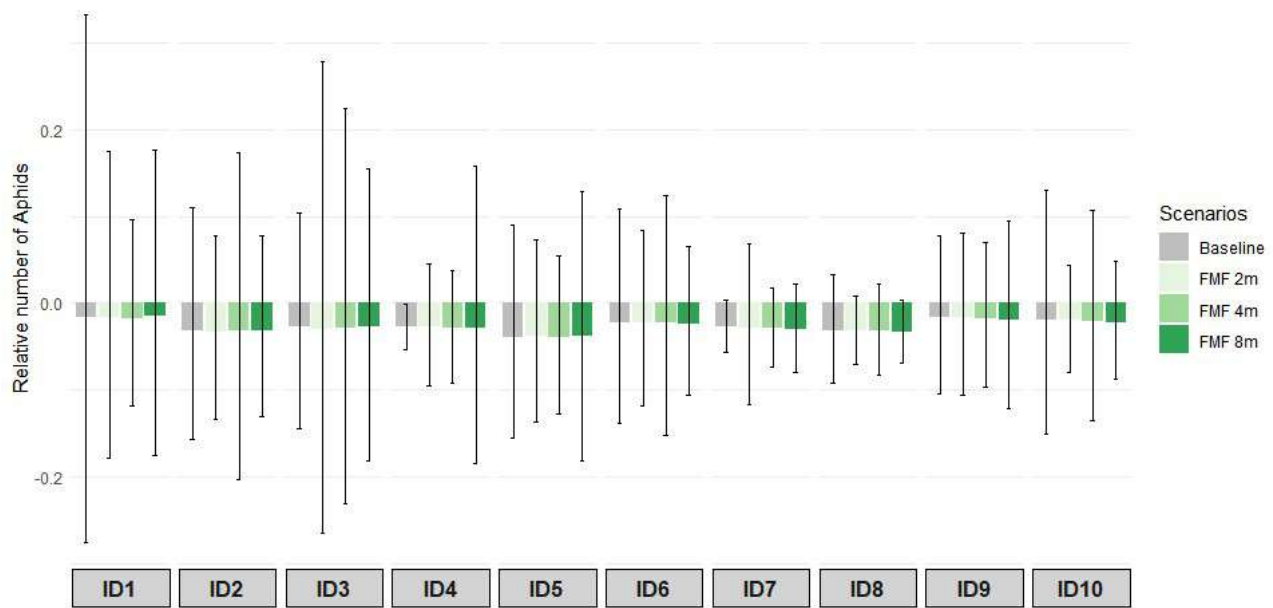


Figure 7.81 Flower field margins scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.6.2 Grass field margins

7.6.2.1 Whole landscape

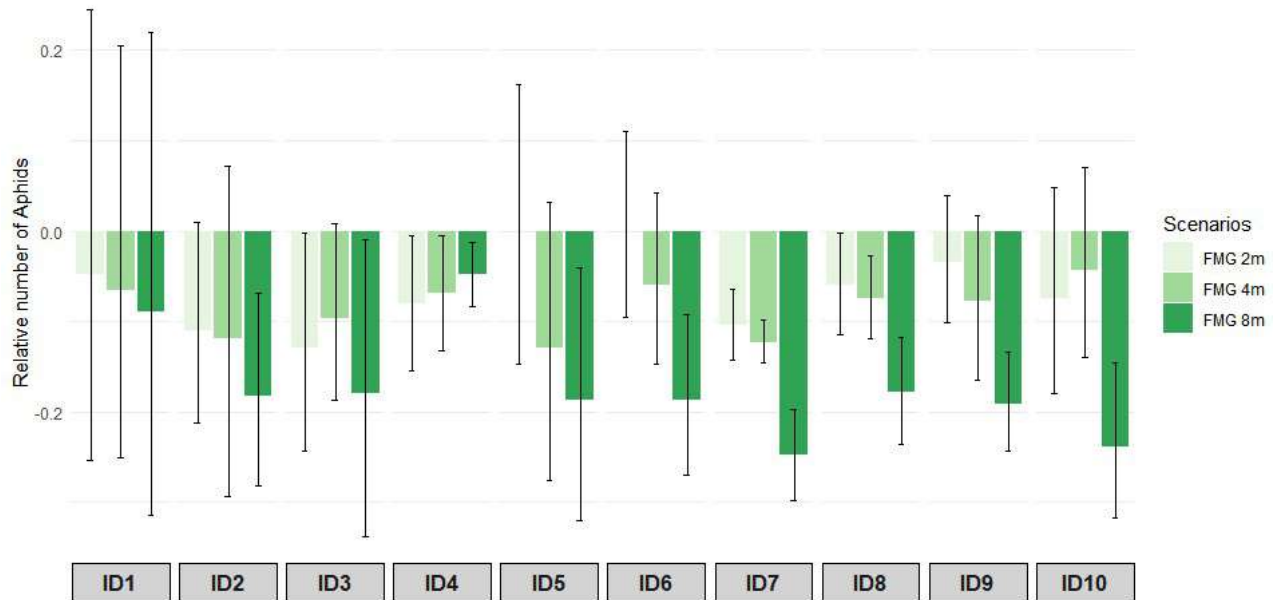


Figure 7.82 Grassy field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.2.2 In-field

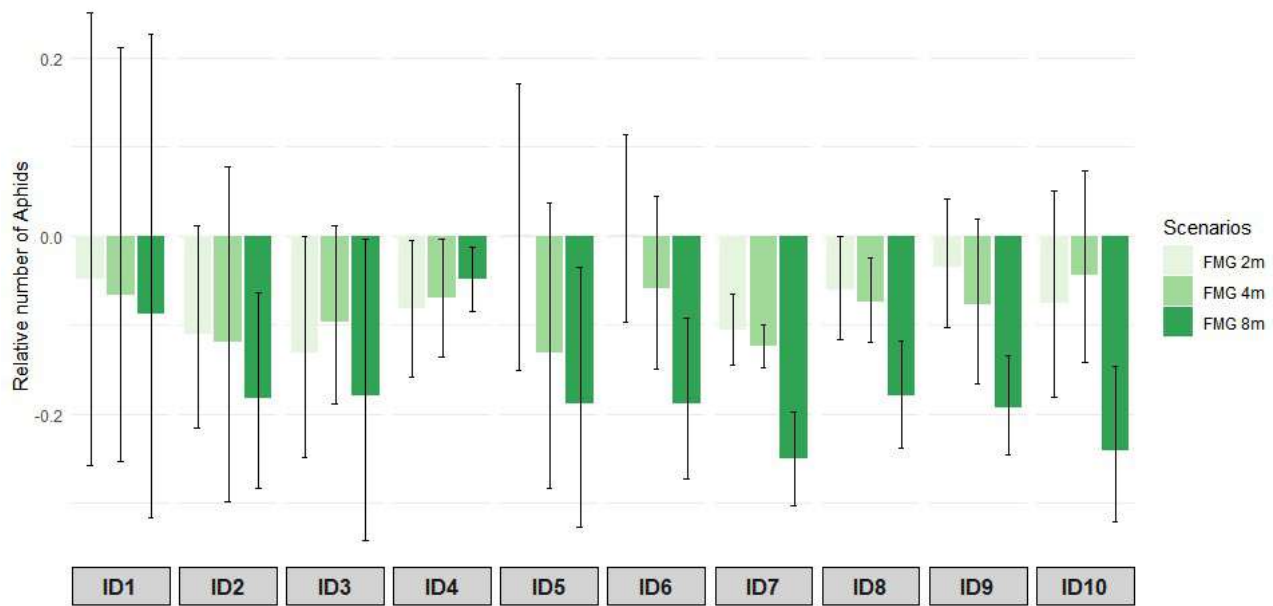


Figure 7.83 Grassy field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.2.3 In-field relative to landscape

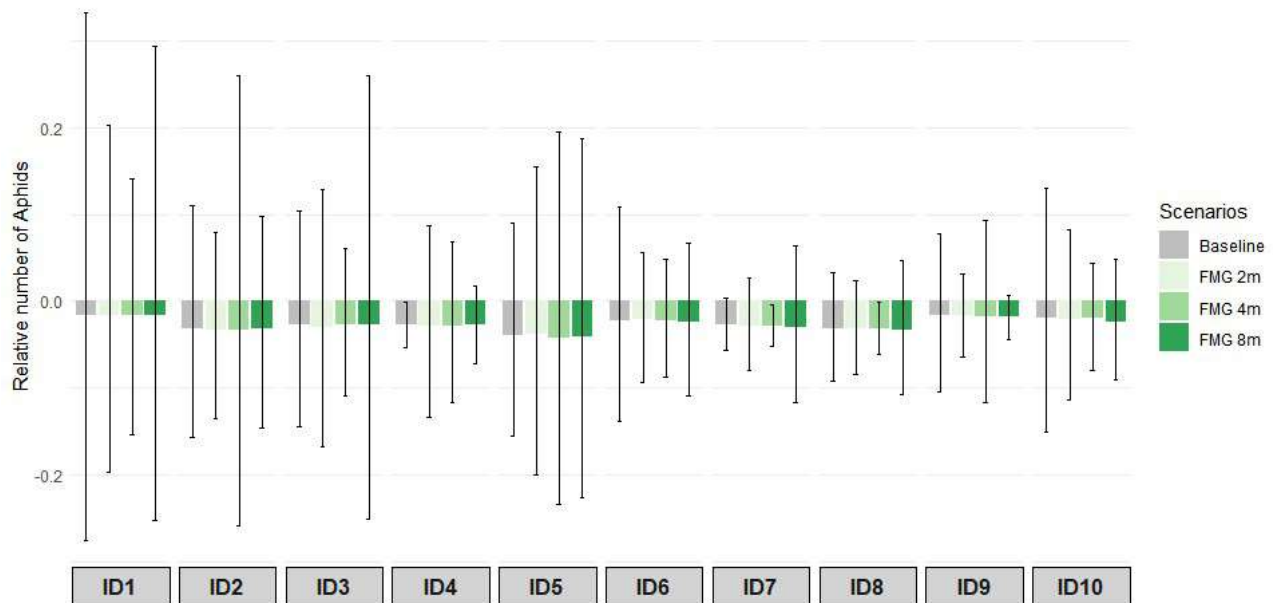


Figure 7.84 Grassy field margins scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.6.3 Mixed field margins

7.6.3.1 Whole landscape

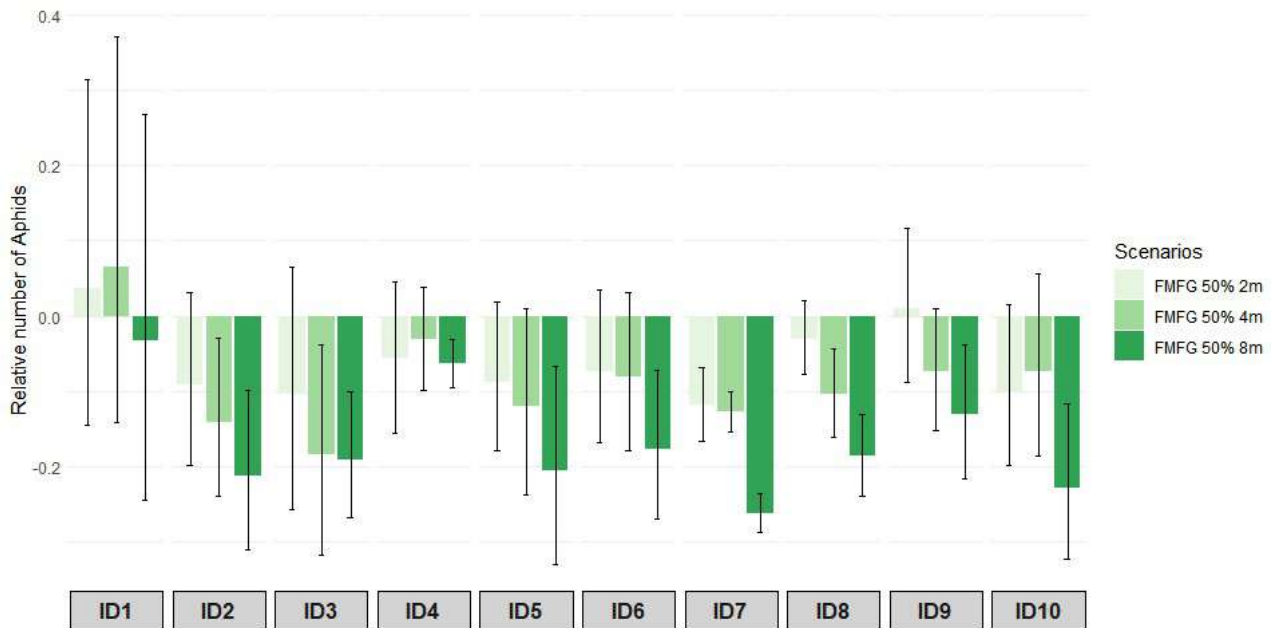


Figure 7.85 Mixed field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.3.2 In-field

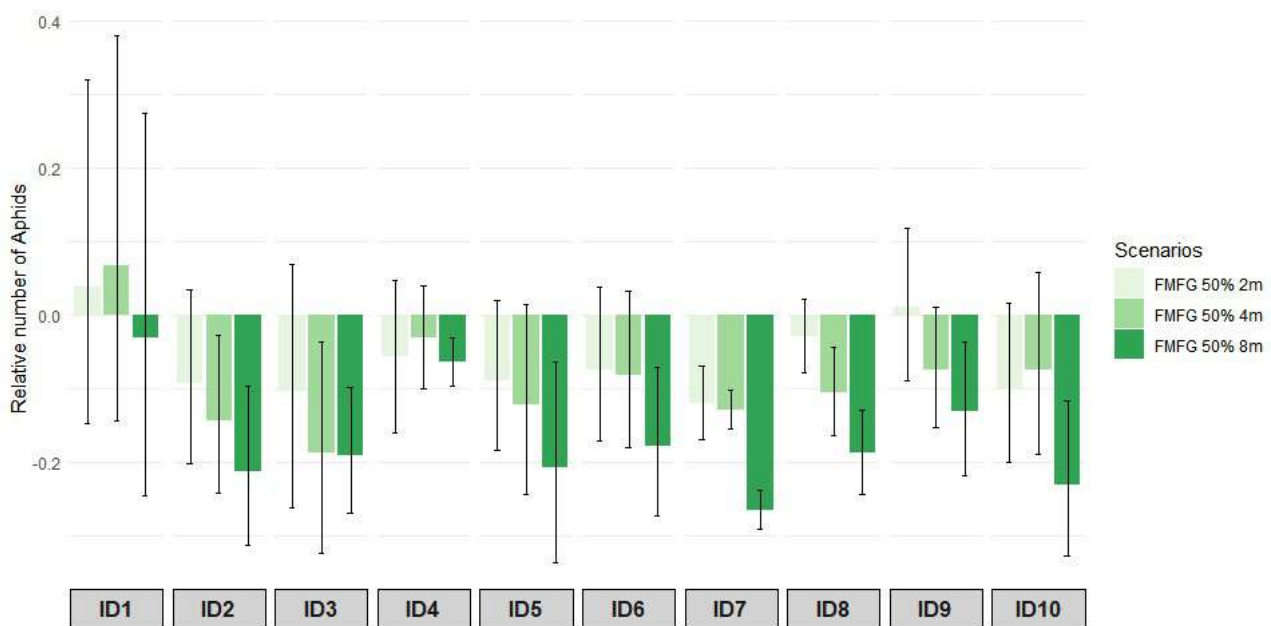


Figure 7.86 Mixed field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.3.3 In-field relative to landscape

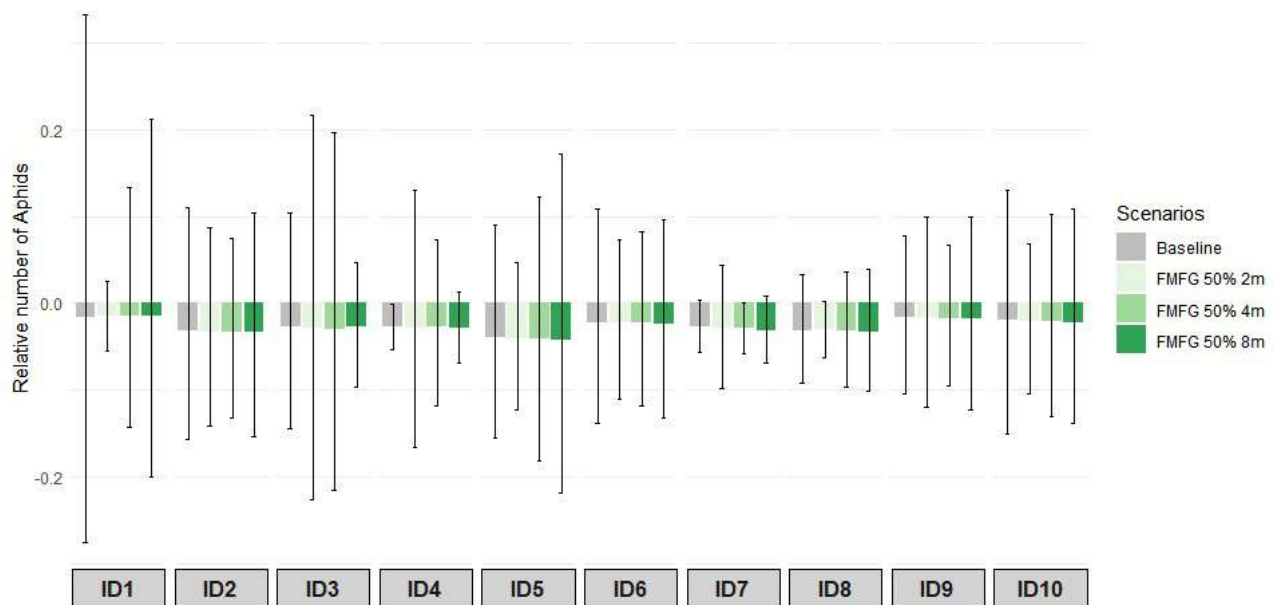


Figure 7.87 Mixed field margins scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.6.4 Flower, grassy and mixed margins

7.6.4.1 Whole landscape

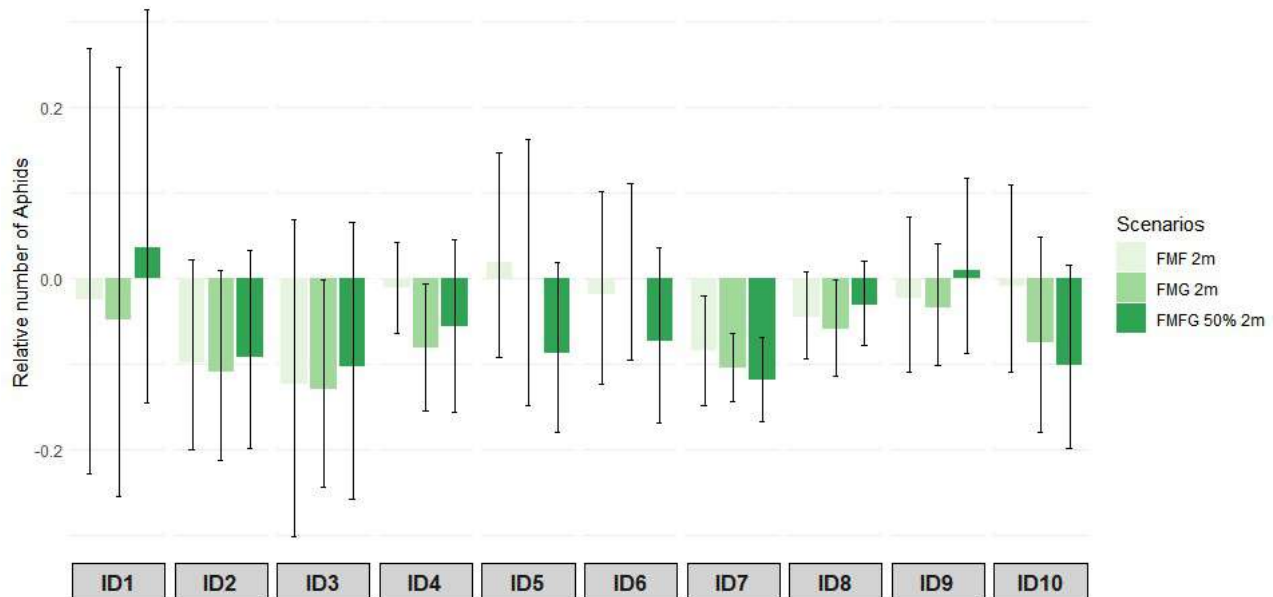


Figure 7.88 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

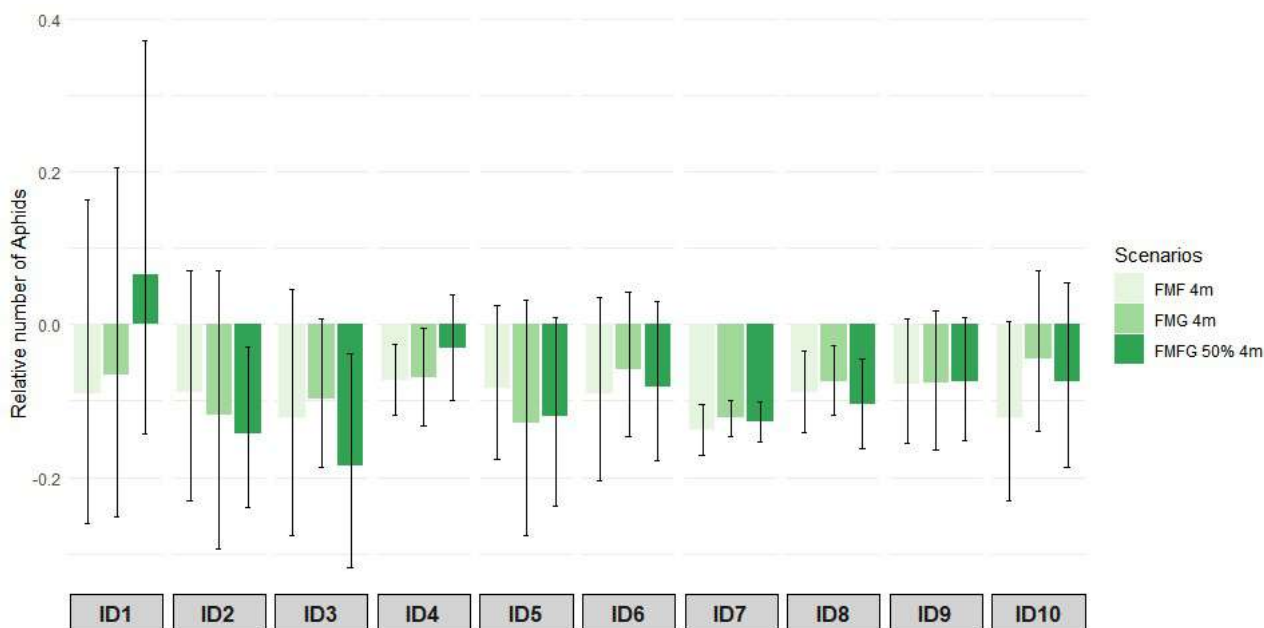


Figure 7.89 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

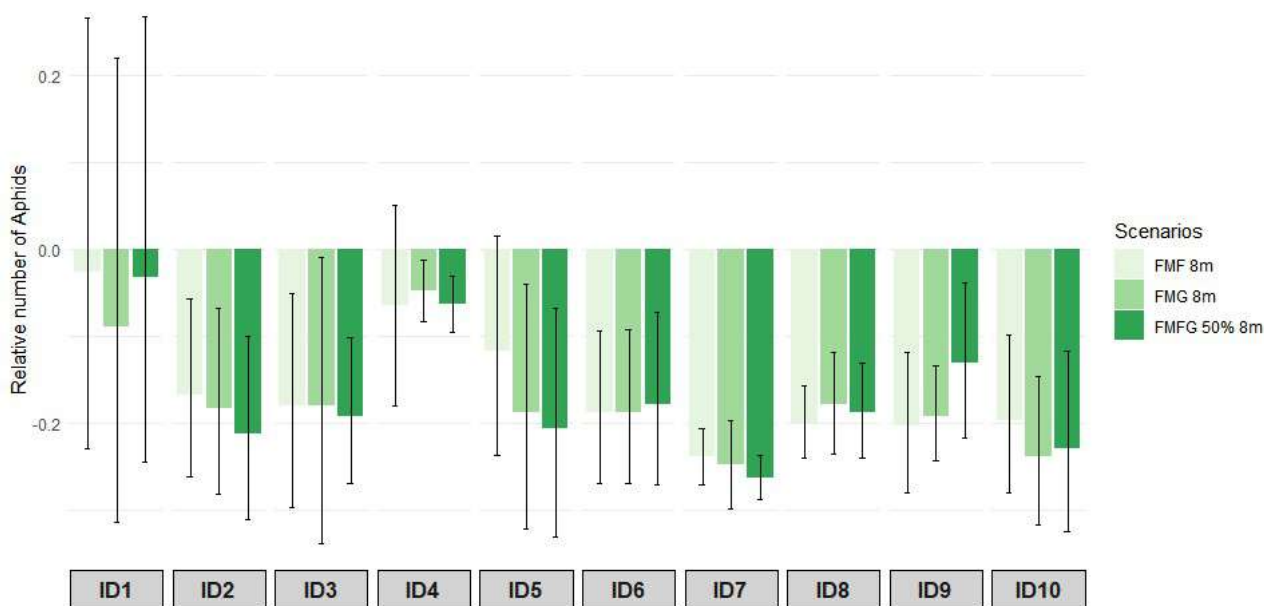


Figure 7.90 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.4.2 In-field

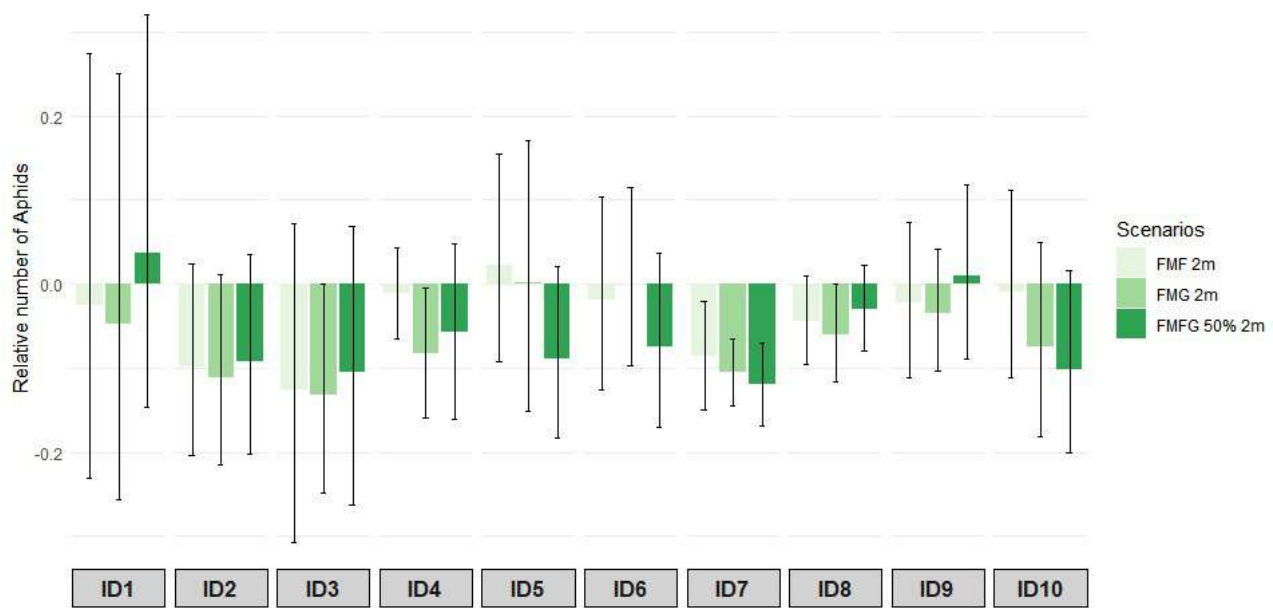


Figure 7.91 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

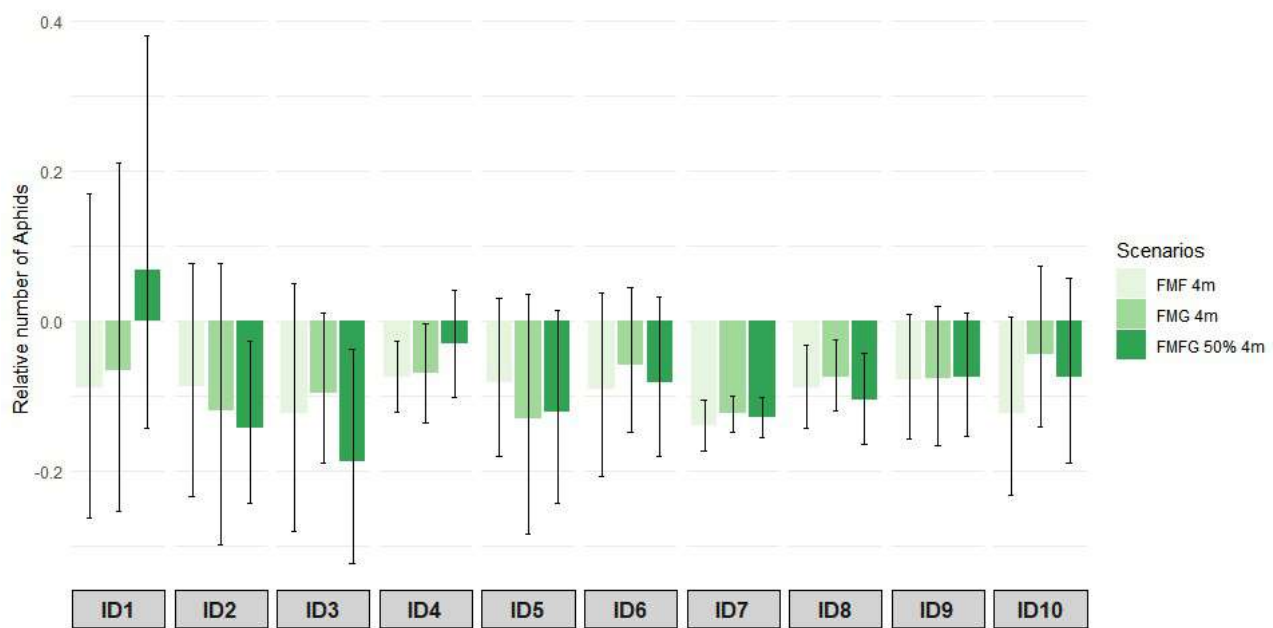


Figure 7.92 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

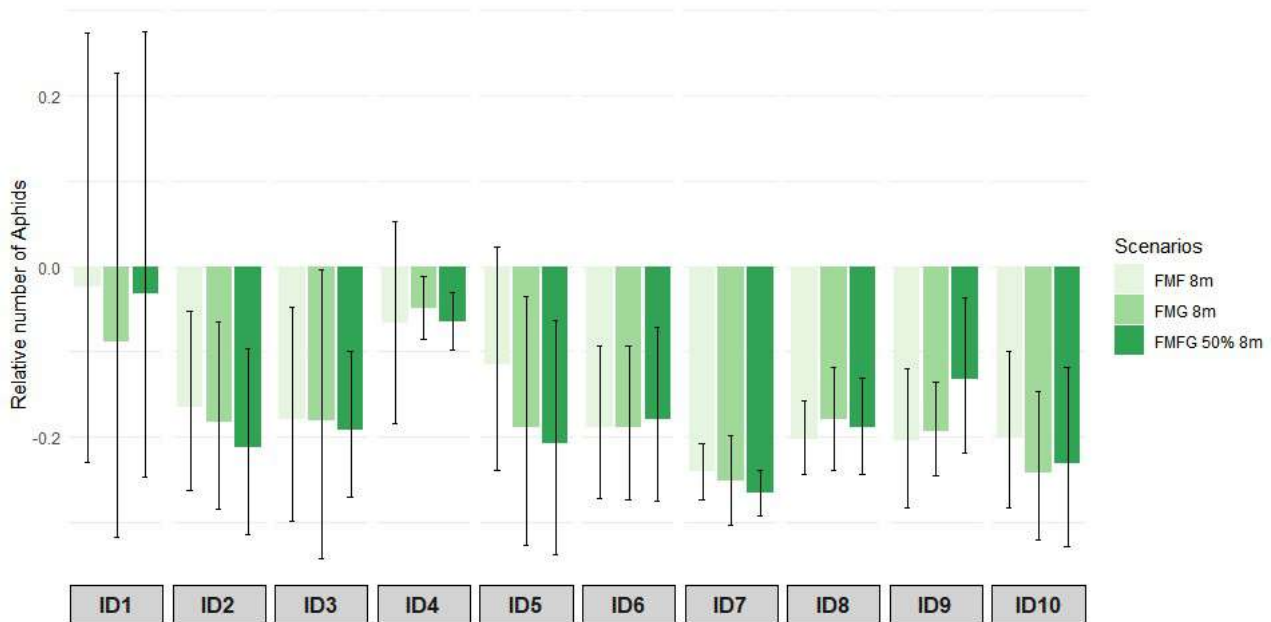


Figure 7.93 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.4.3 In-field relative to landscape

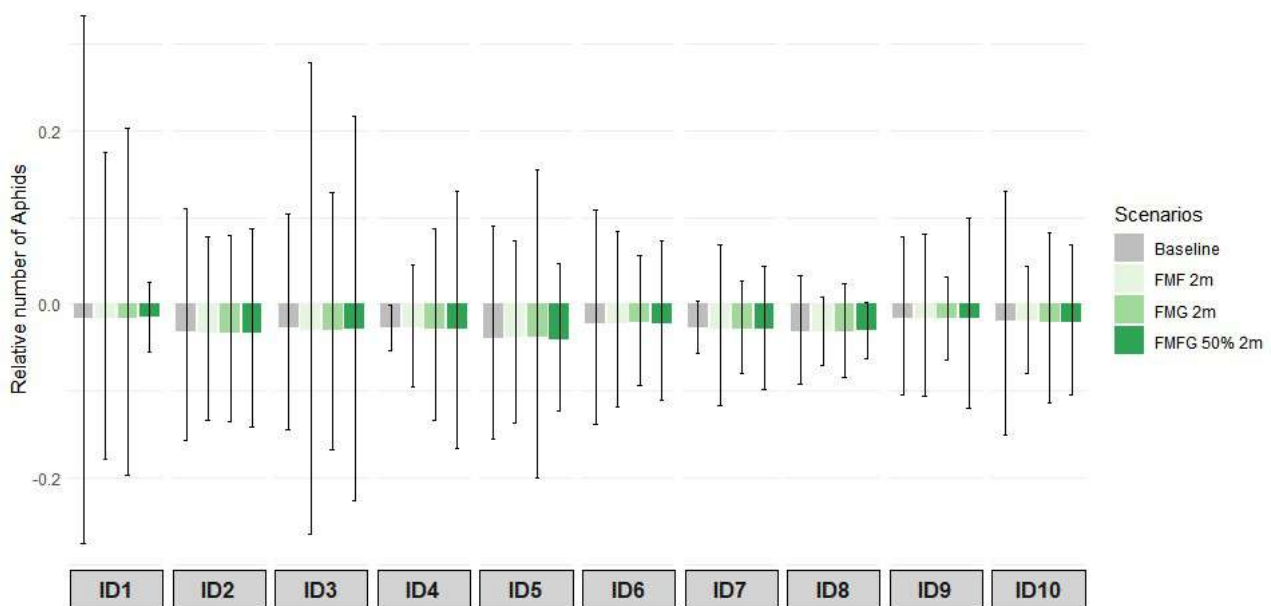


Figure 7.94 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

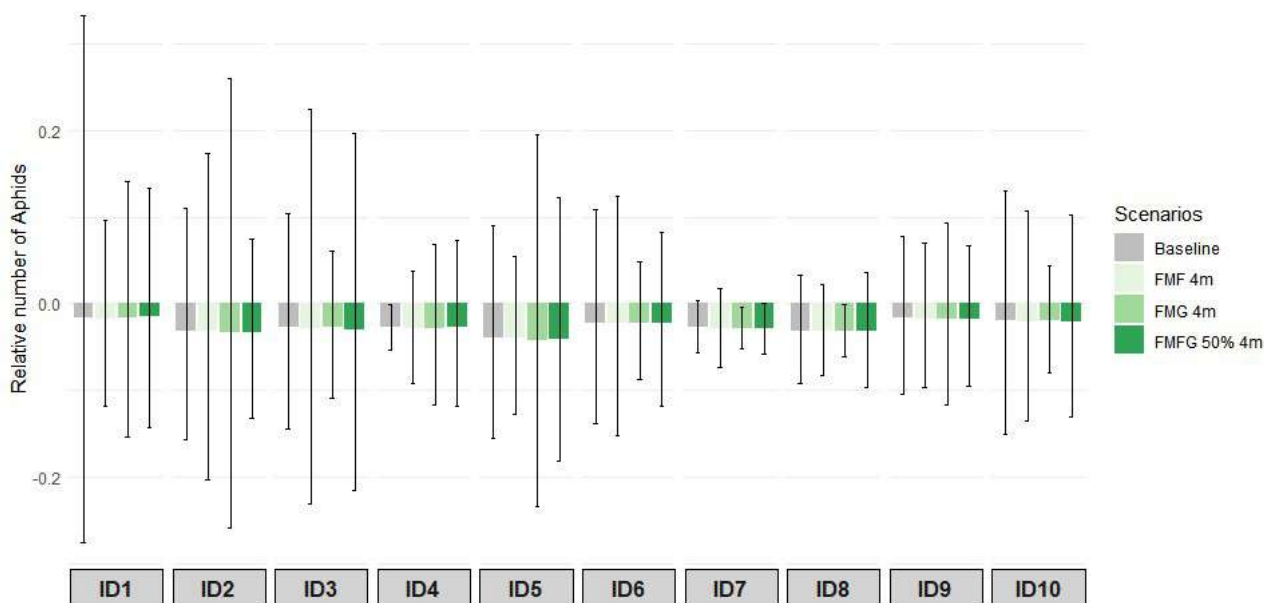


Figure 7.95 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

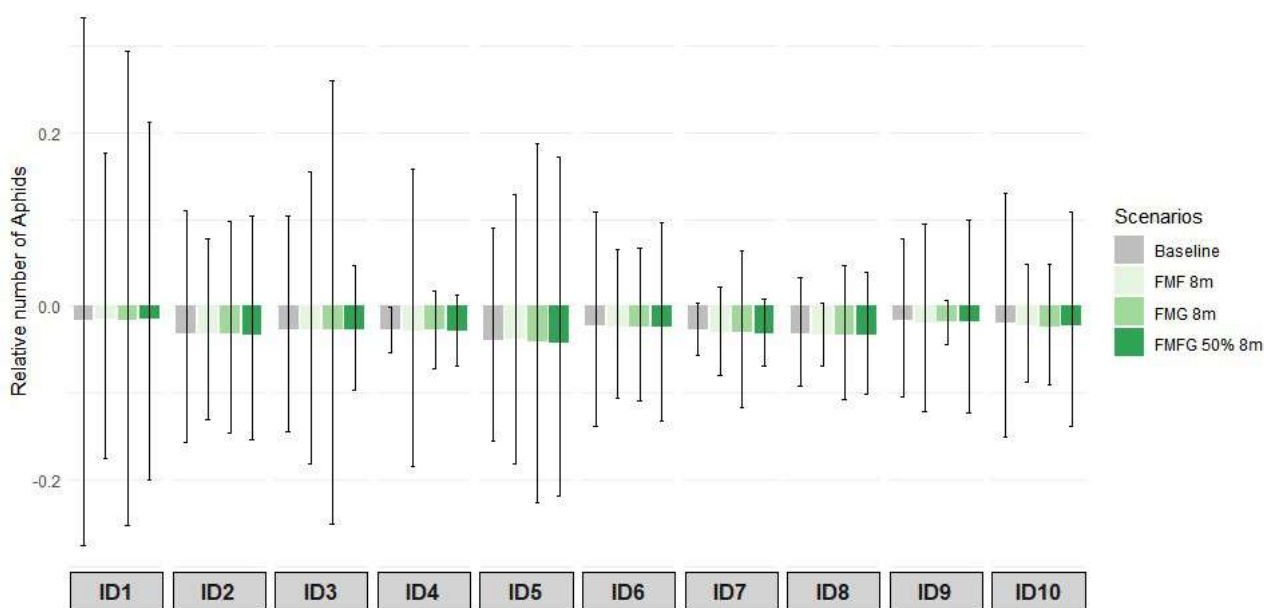


Figure 7.96 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.6.5 Setaside

7.6.5.1 Whole landscape

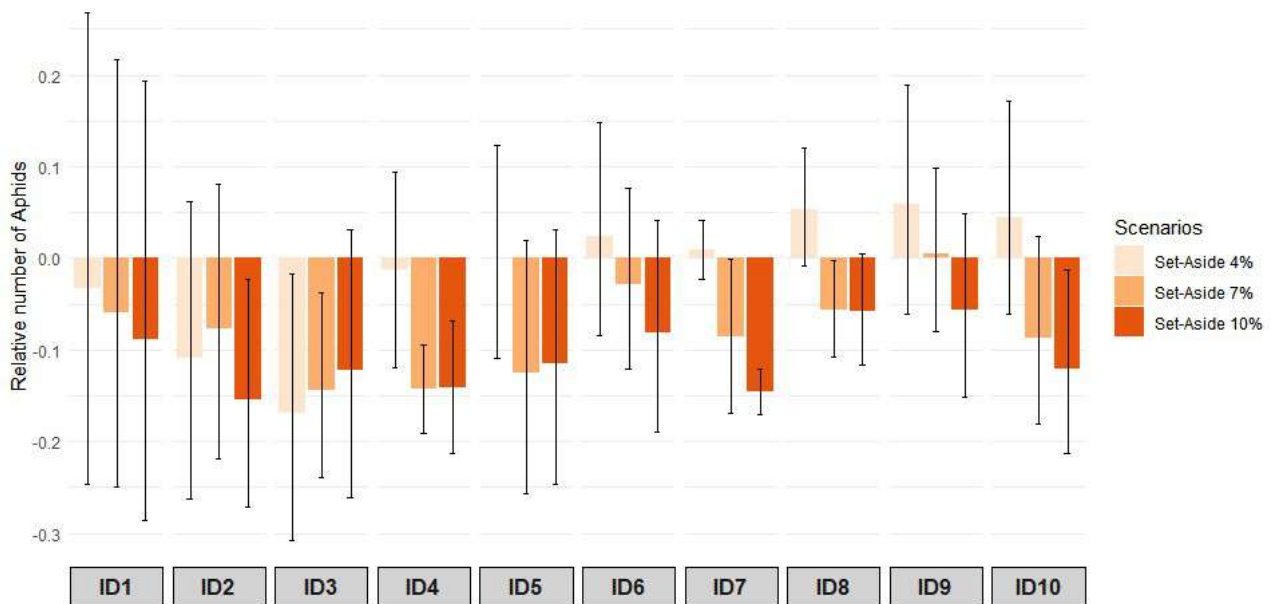


Figure 7.96 Setaside scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.5.2 In-field

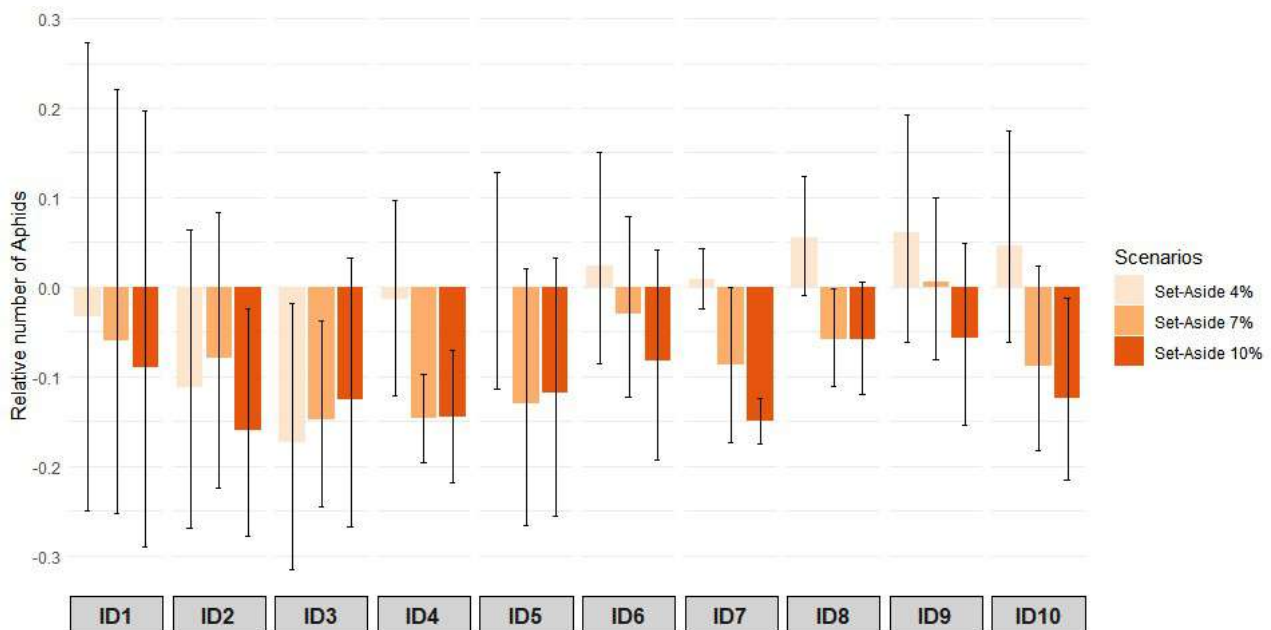


Figure 7.97 Setaside scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.5.3 In-field relative to landscape

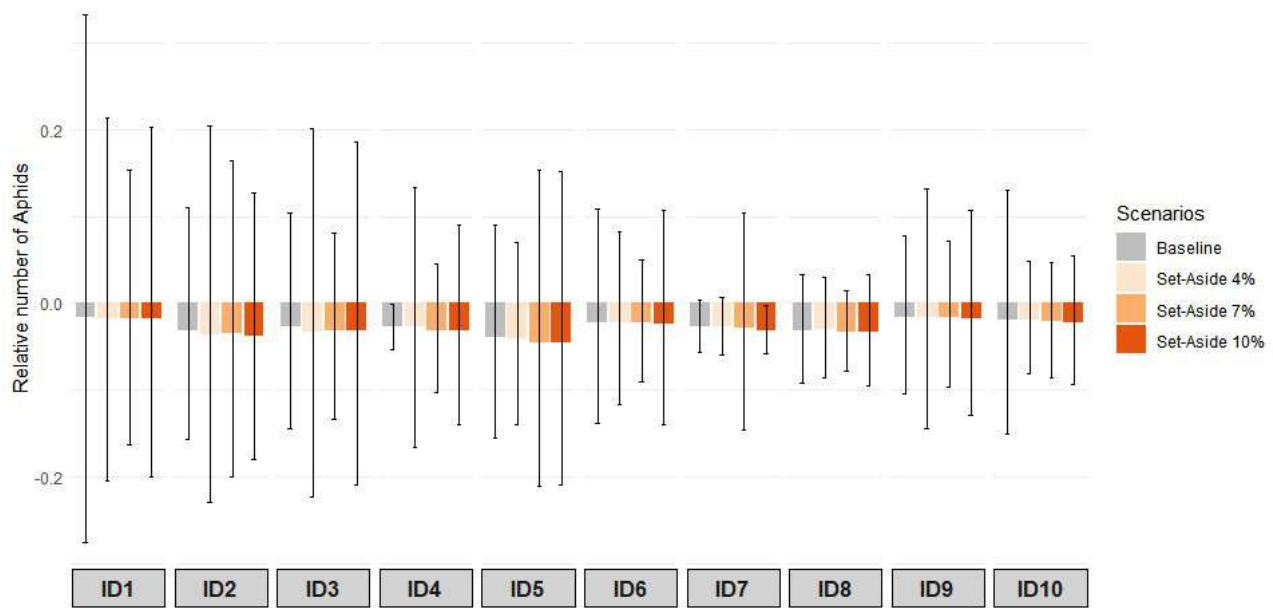


Figure 7.98 Setaside scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.6.6 Legume

7.6.6.1 Whole landscape

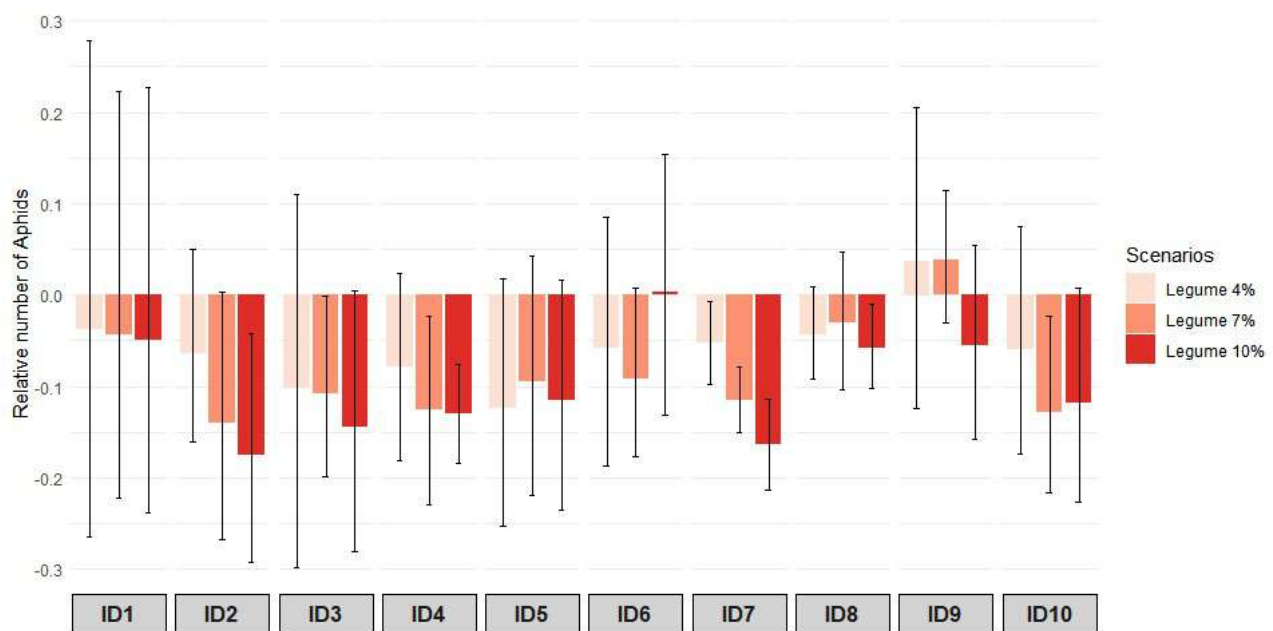


Figure 7.99 Legume scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.6.2 In-field

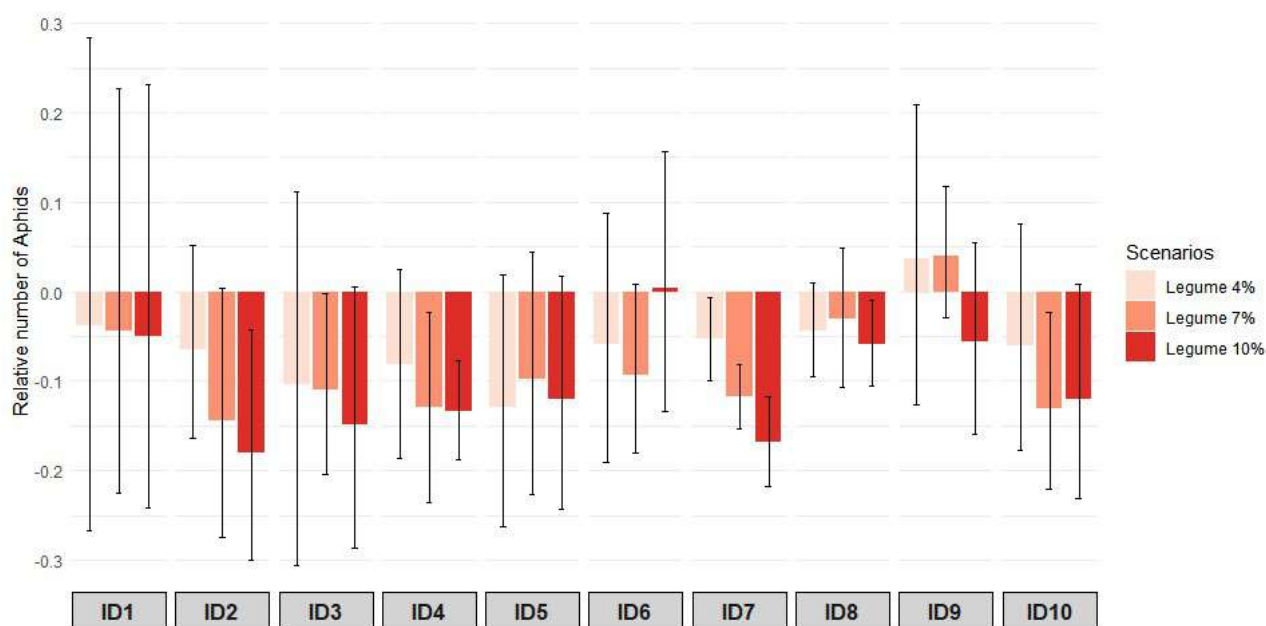


Figure 7.100 Legume scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.6.3 In-field relative to landscape

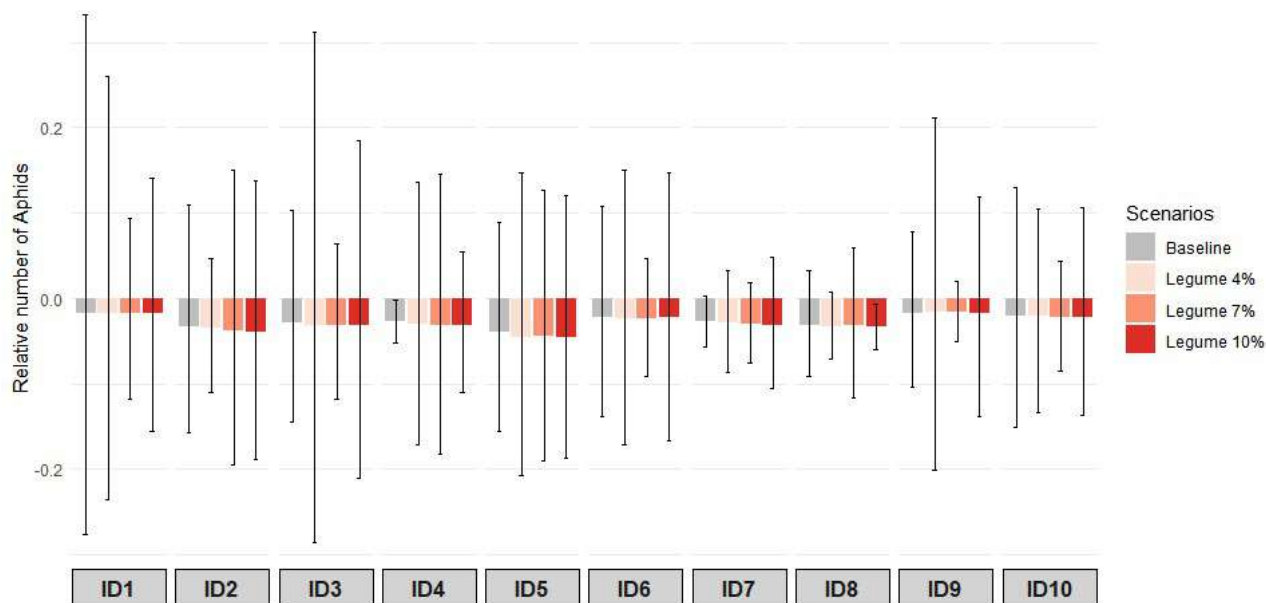


Figure 7.101 Legume scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.6.7 Biopesticides

7.6.7.1 Whole landscape

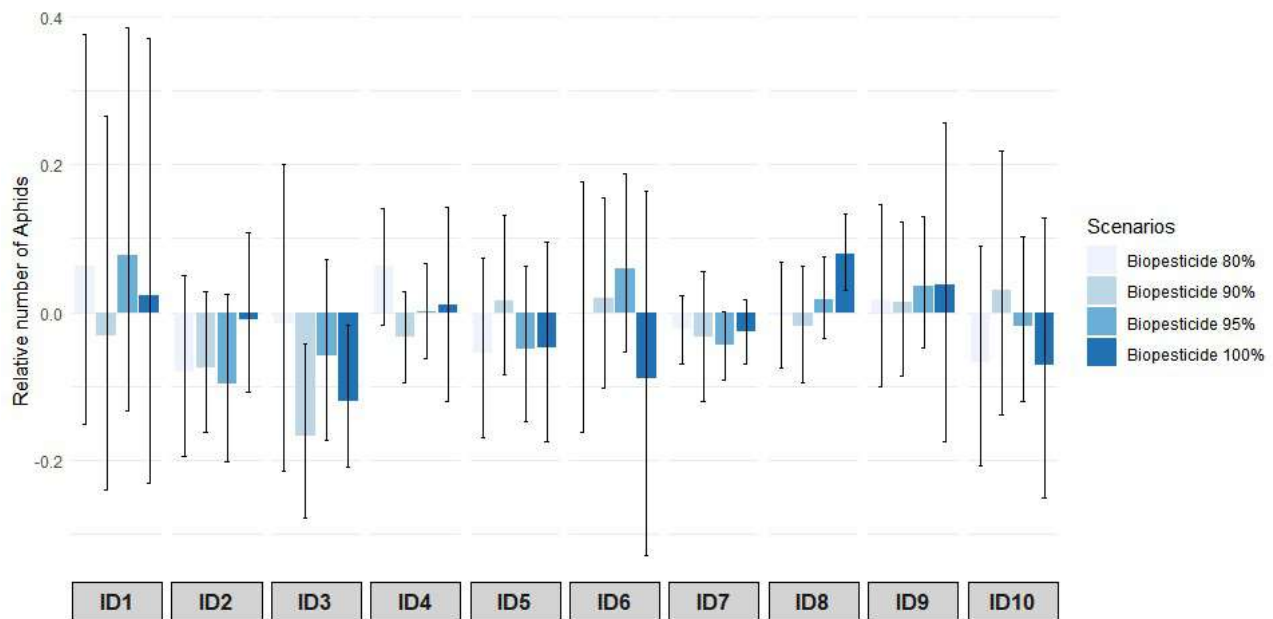


Figure 7.102 Biopesticide scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.6.7.2 In-field

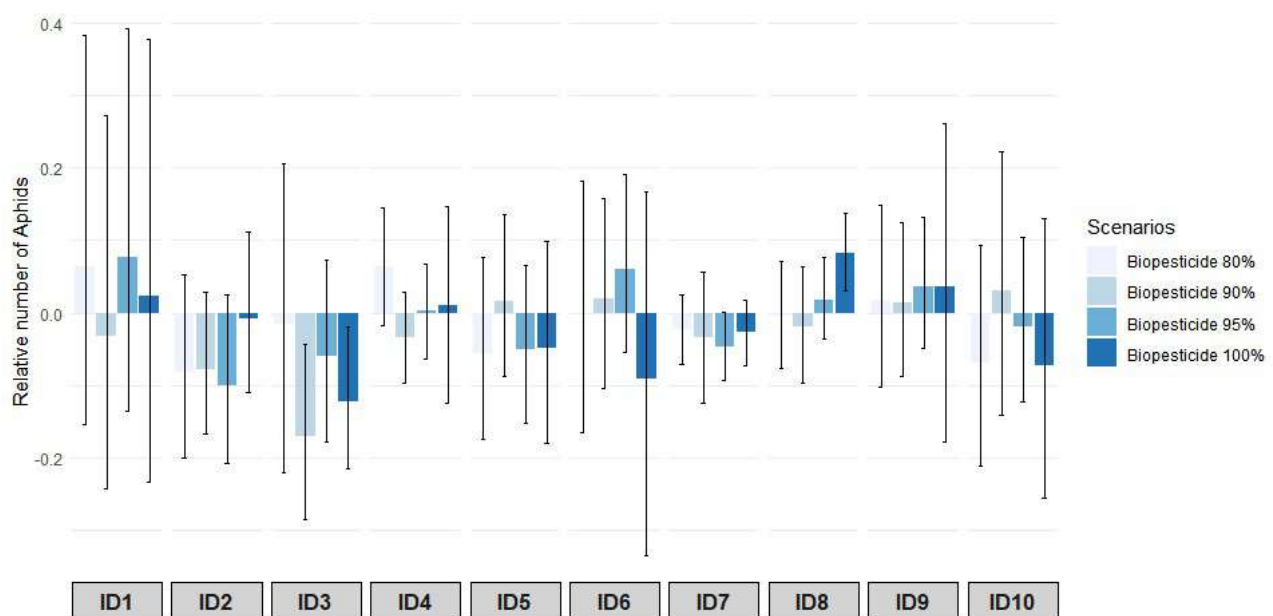


Figure 7.103 Biopesticide scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.6.7.3 In-field relative to landscape

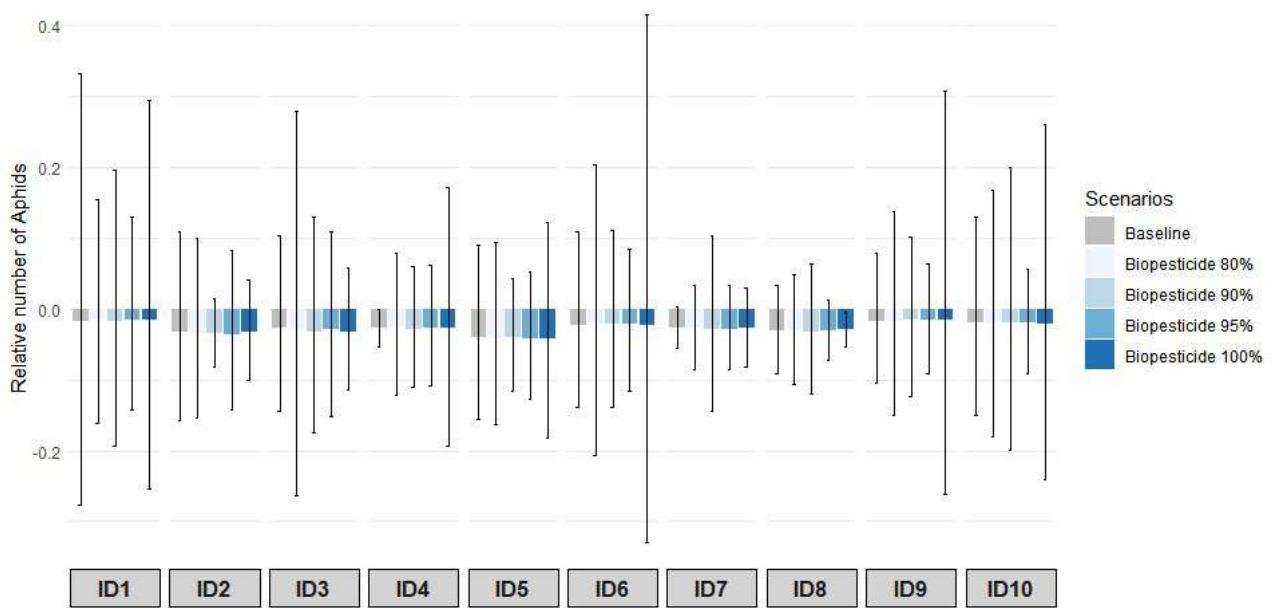


Figure 7.104 Biopesticide scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.7 Denmark

7.7.1 Crop diversification

7.7.1.1 Whole landscape

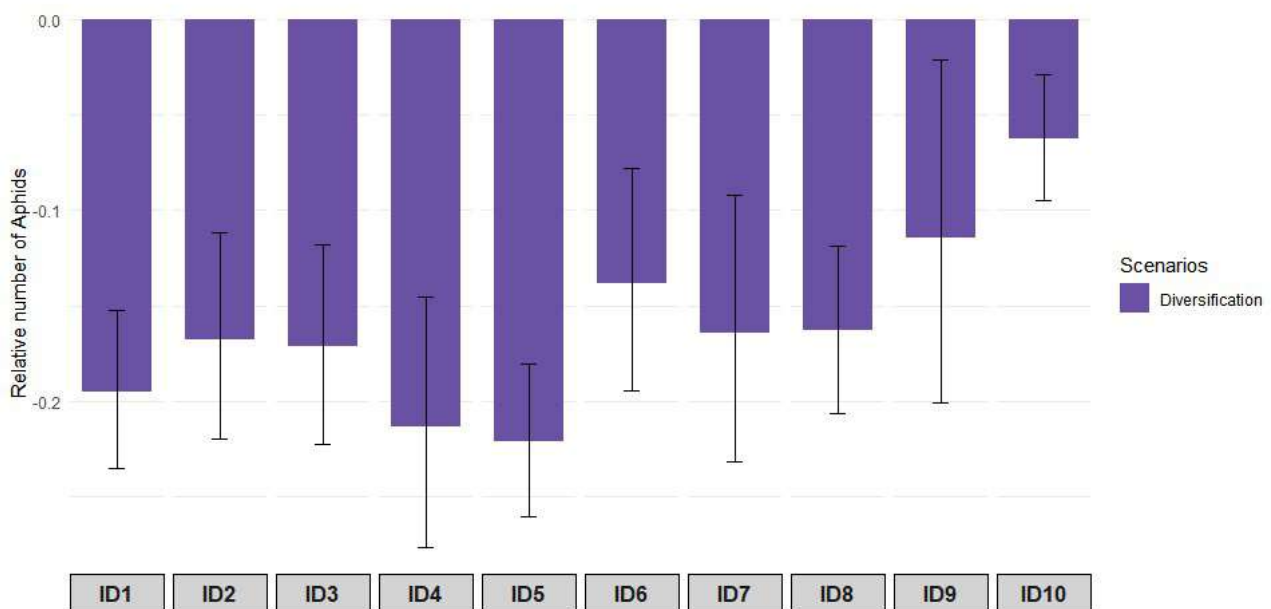


Figure 7.105 Diversification scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.1.2 In-field

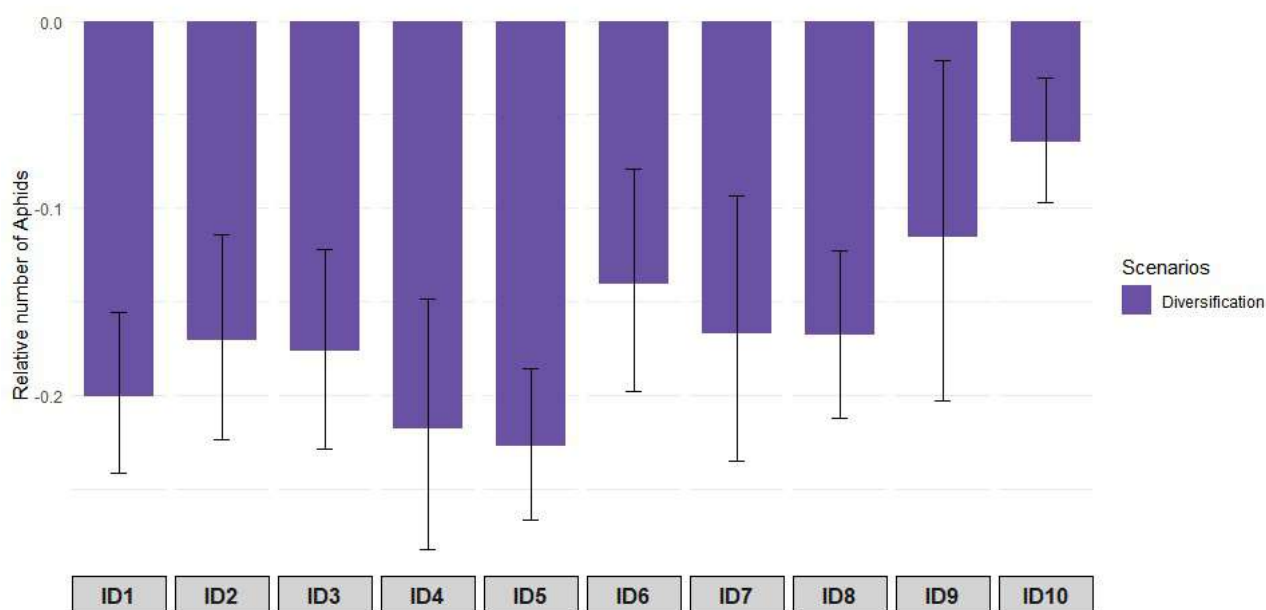


Figure 7.106 Diversification scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.1.3 In-field relative to landscape

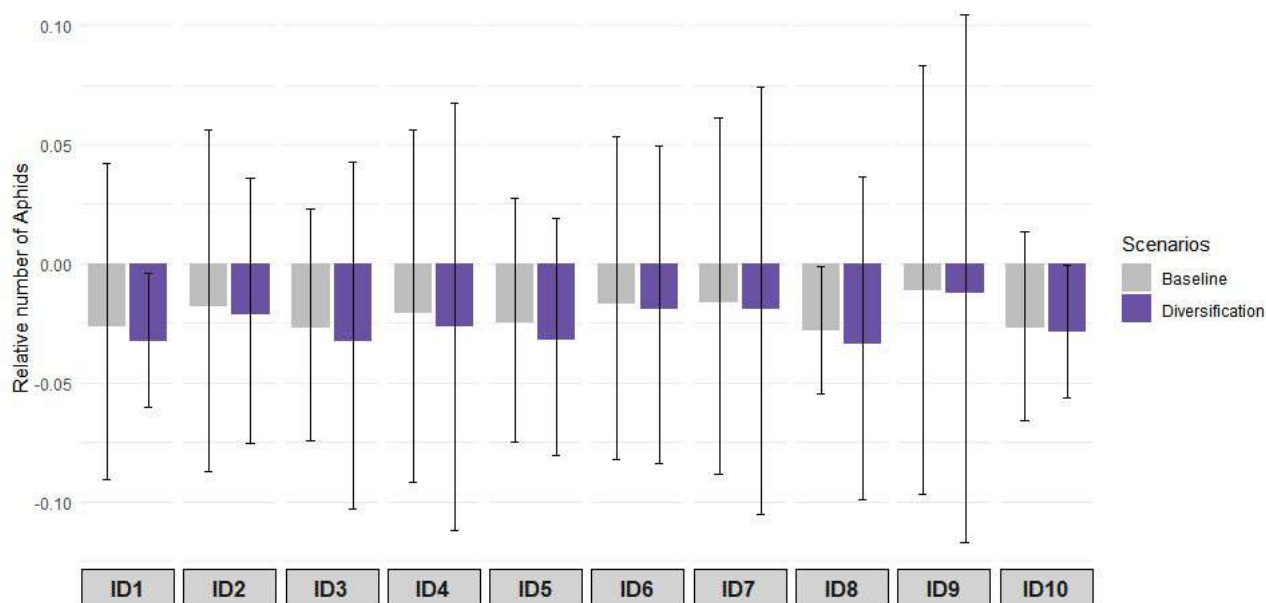


Figure 7.107 Diversification scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.2 Flower field margins

7.7.2.1 Whole landscape

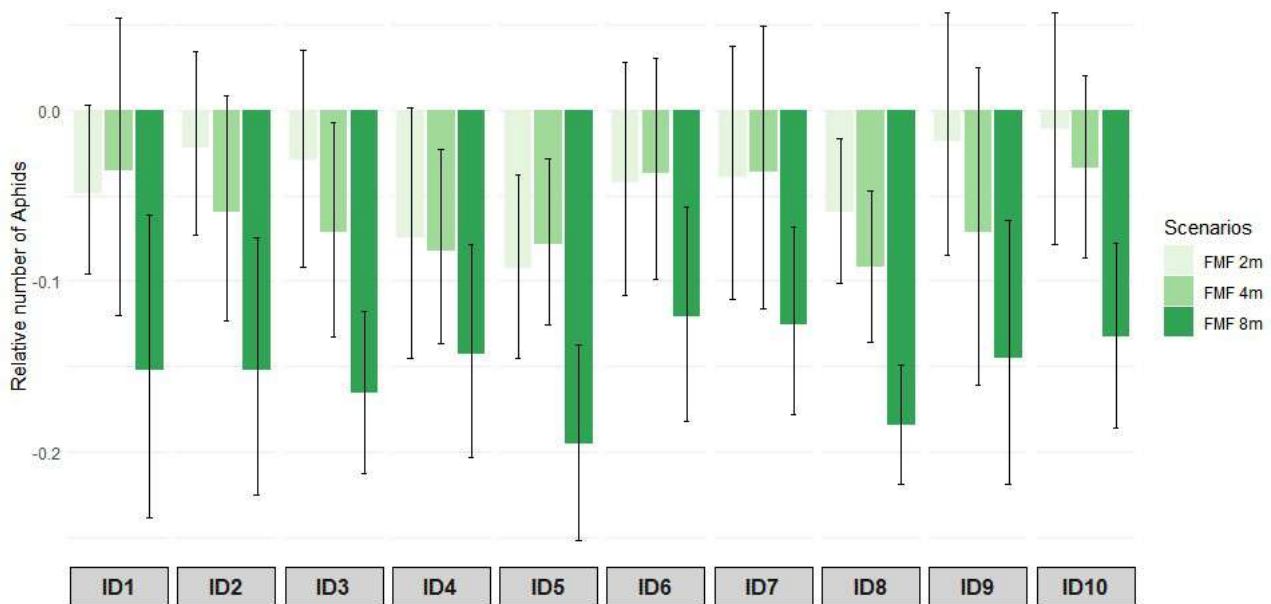


Figure 7.108 Flower field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.2.2 In-field

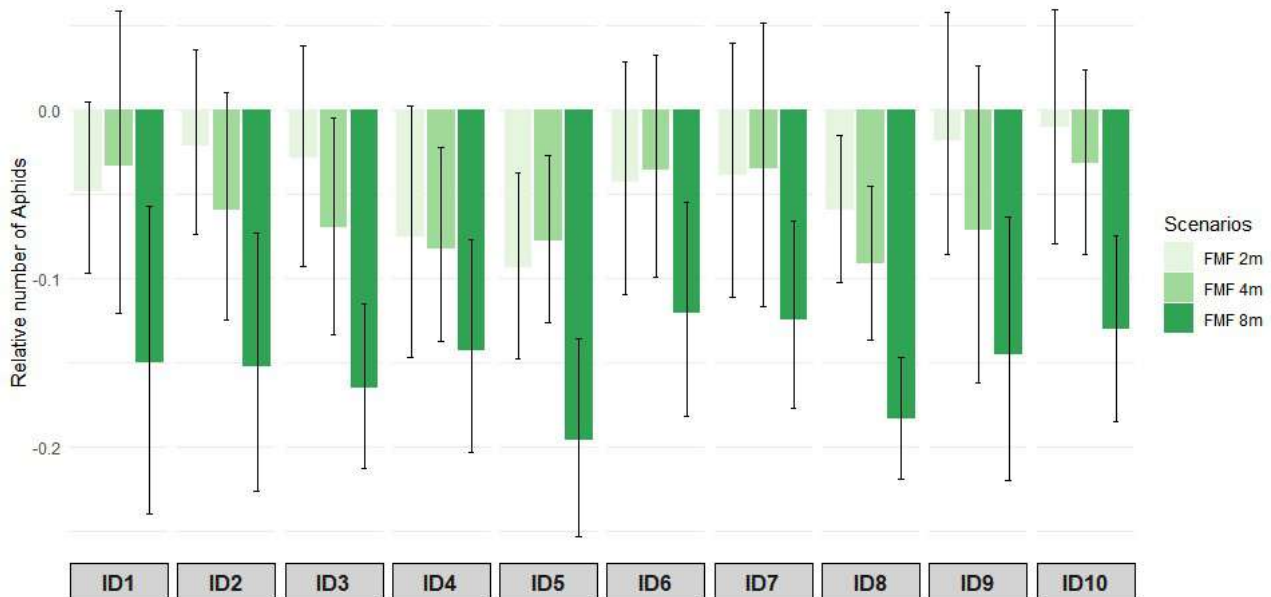


Figure 7.109 Flower field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.2.3 In-field relative to landscape

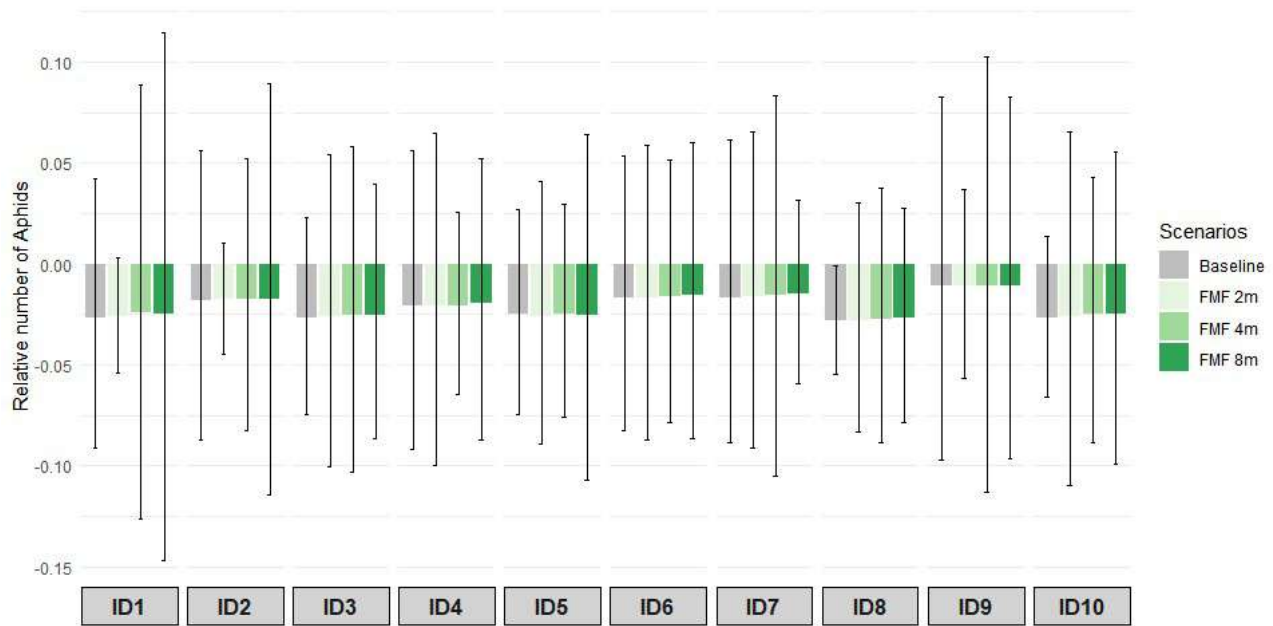


Figure 7.110 Flower field margins scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.3 Grass field margins

7.7.3.1 Whole landscape

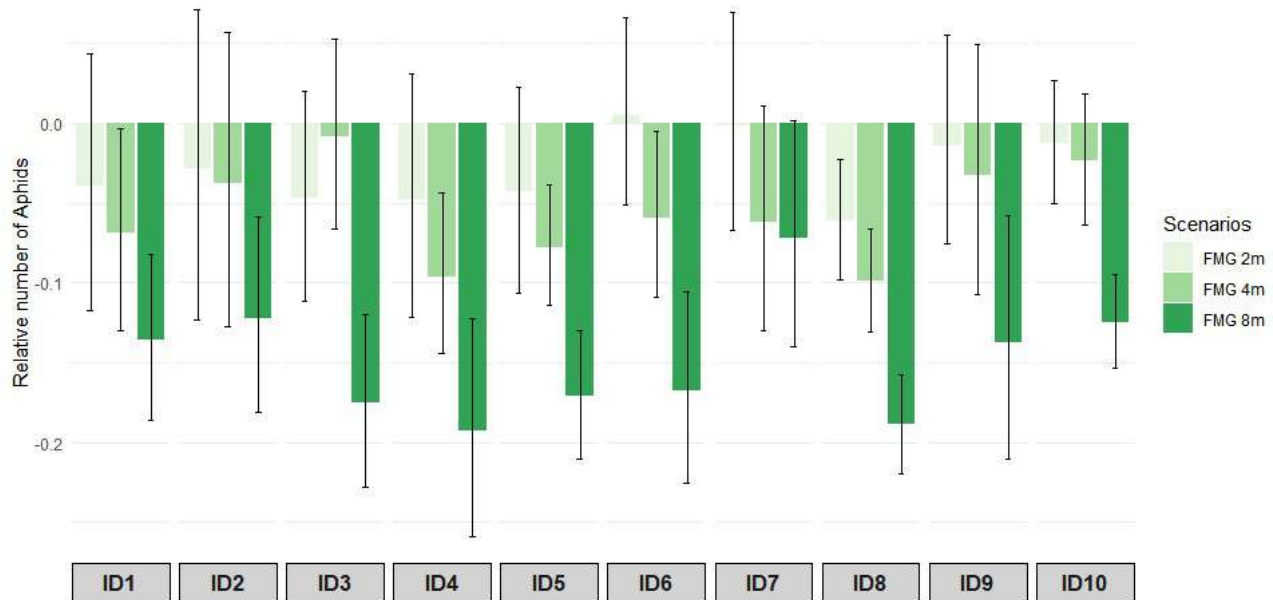


Figure 7.111 Grassy field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.3.2 In-field

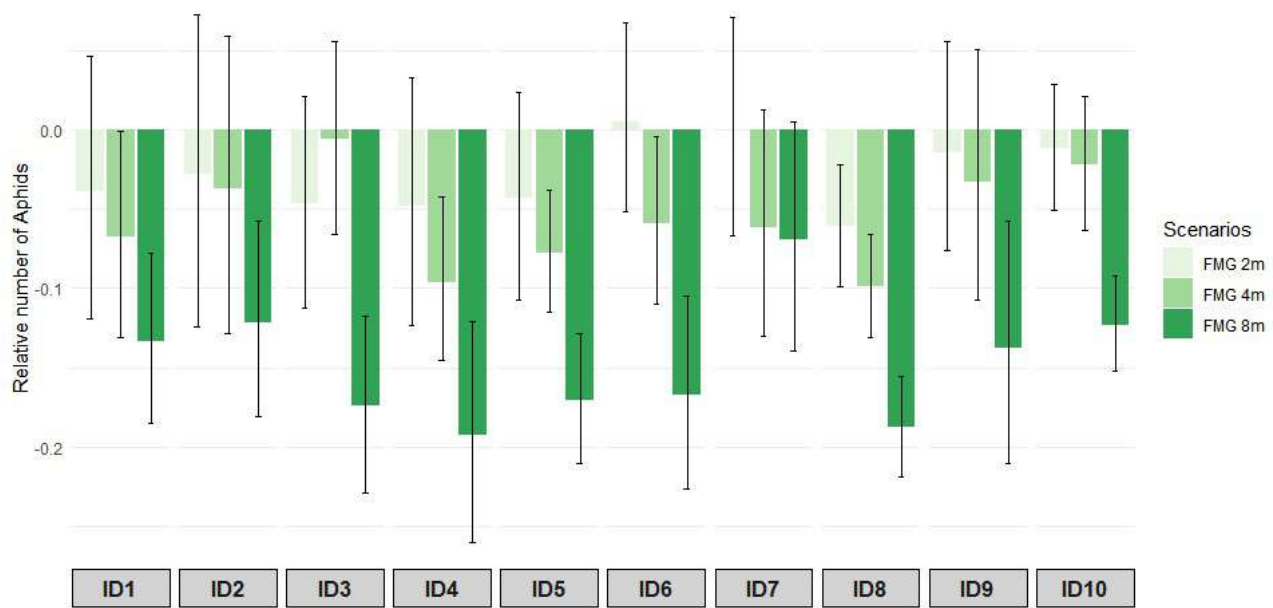


Figure 7.112 Grassy field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.3.3 In-field relative to landscape

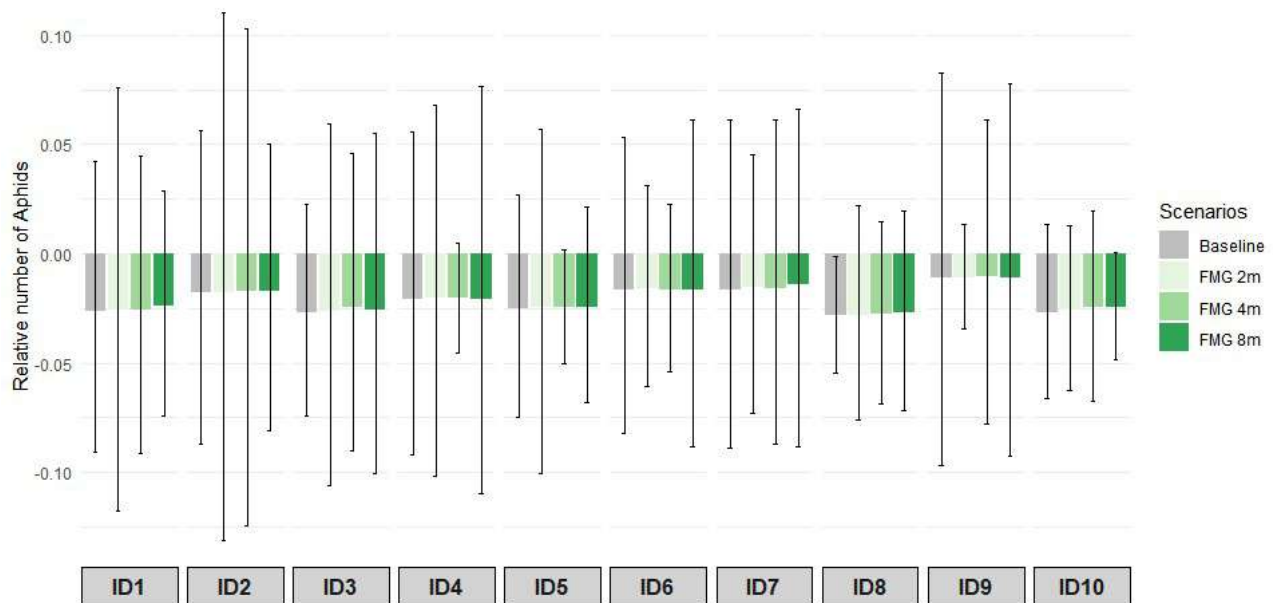


Figure 7.113 Grassy field margins scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.4 Mixed field margins

7.7.4.1 Whole landscape

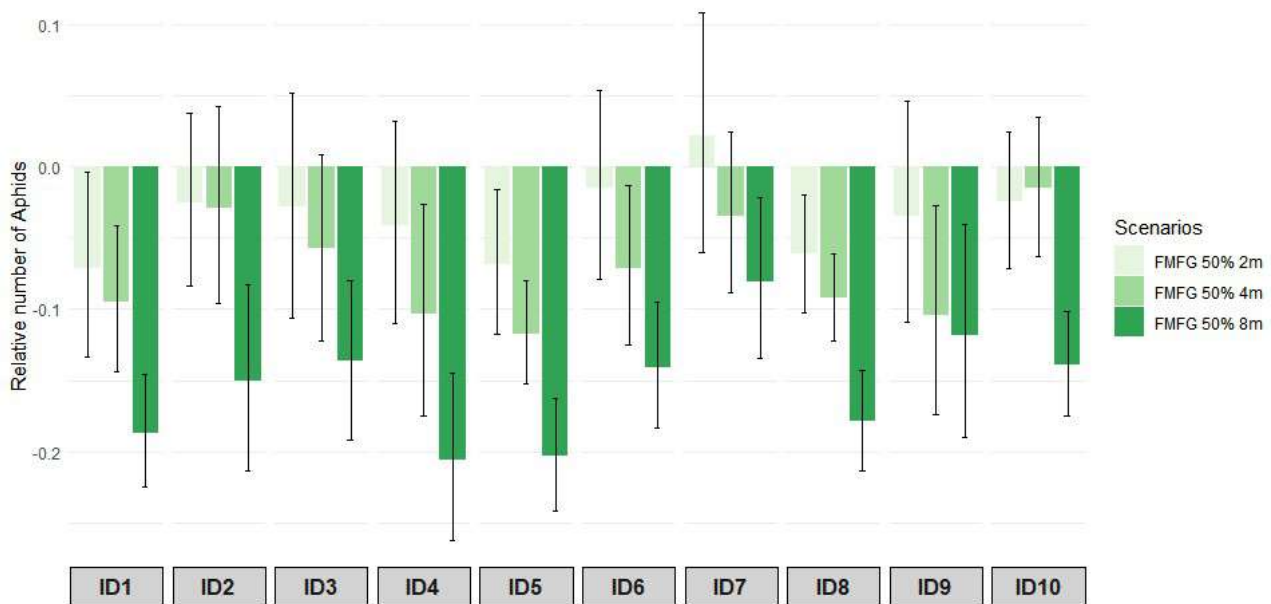


Figure 7.114 Mixed field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.4.2 In-field

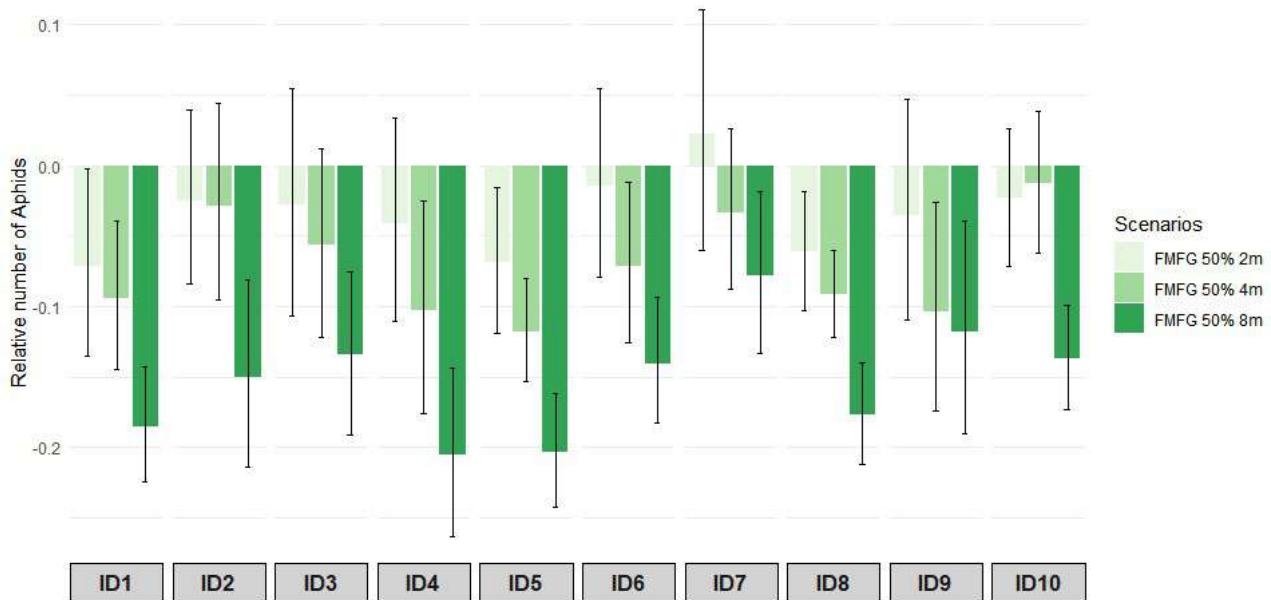


Figure 7.115 Mixed field margins scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.4.3 In-field relative to landscape

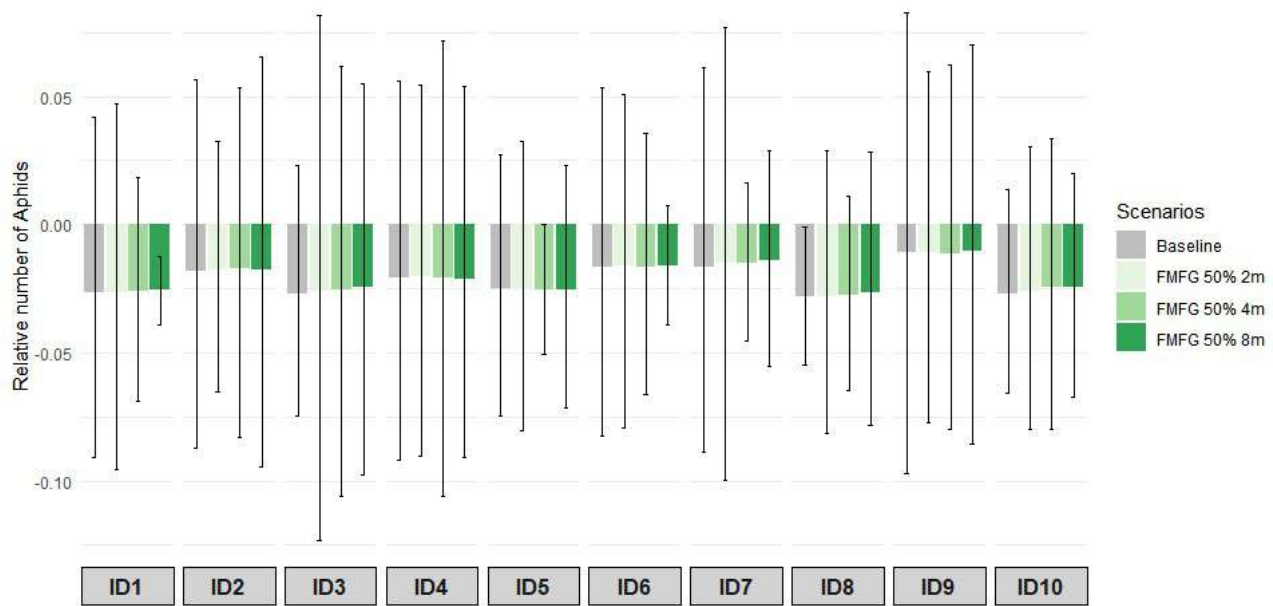


Figure 7.116 Mixed field margins scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.5 Flower, grassy and mixed margins

7.7.5.1 Whole landscape

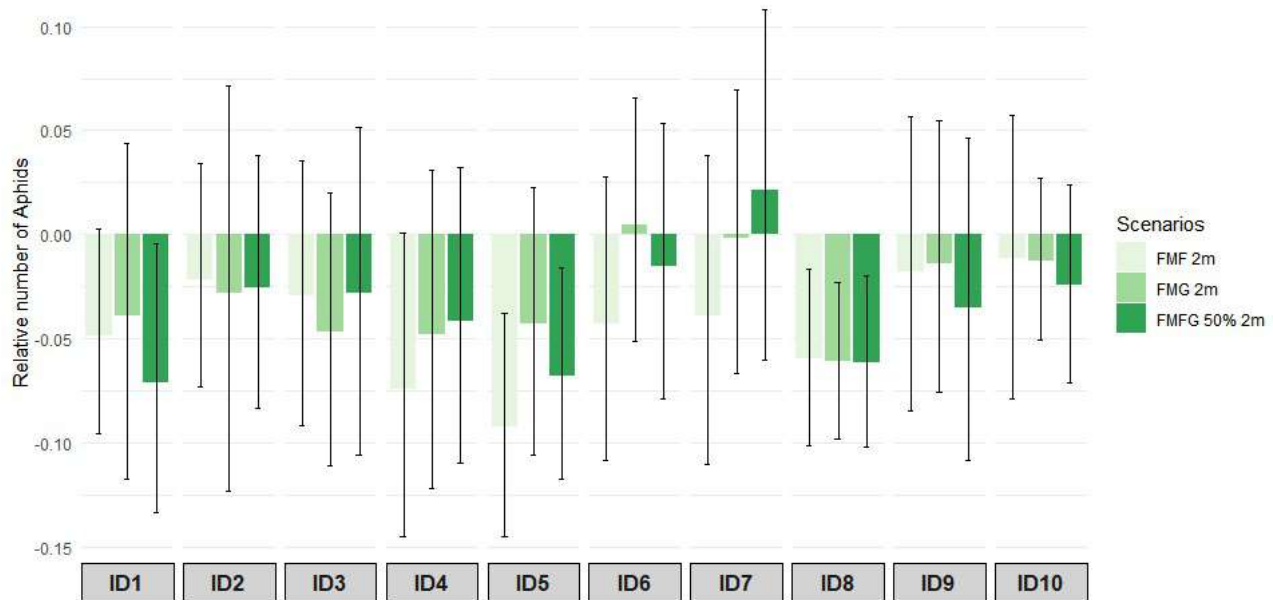


Figure 7.117 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

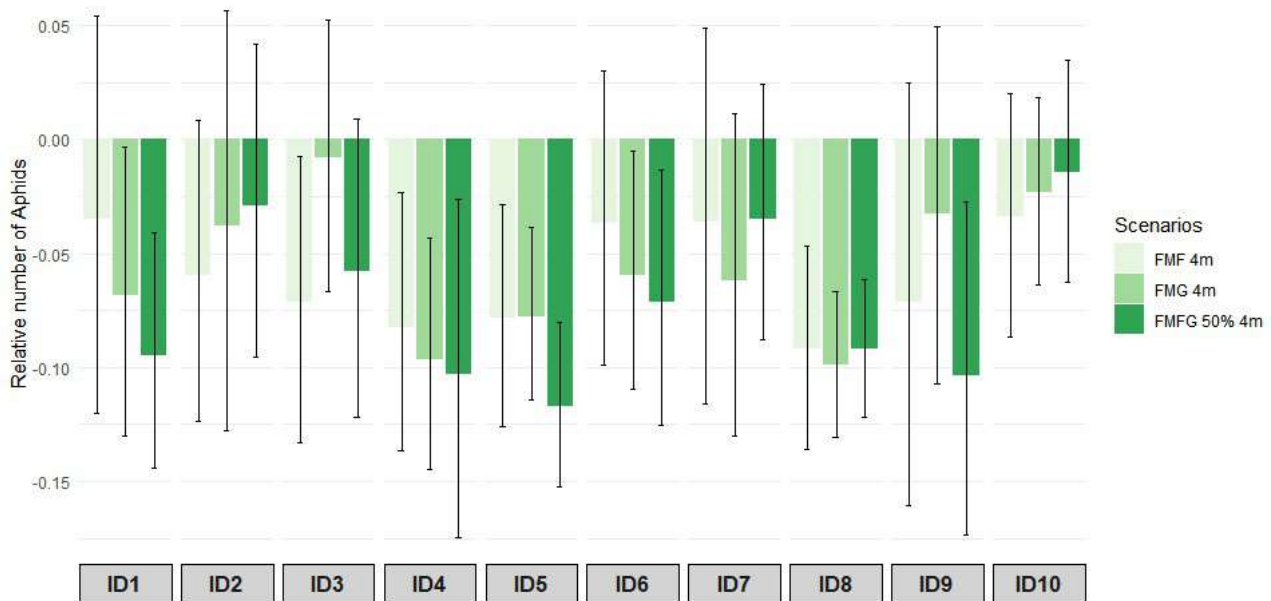


Figure 7.118 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

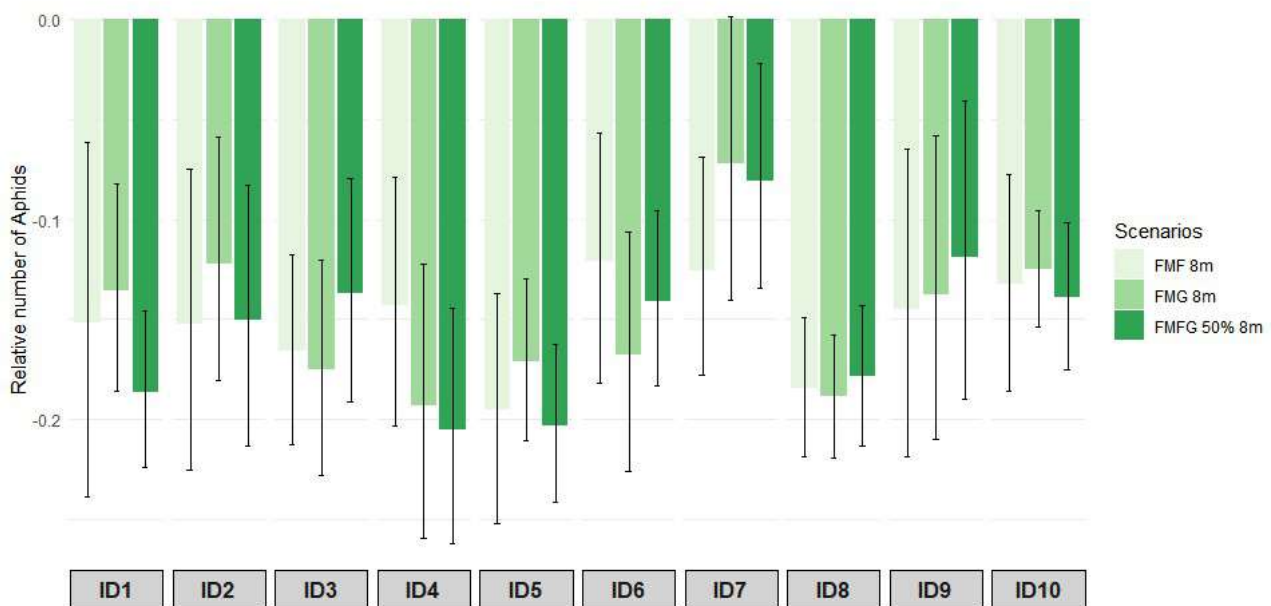


Figure 7.119 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.5.2 In-field

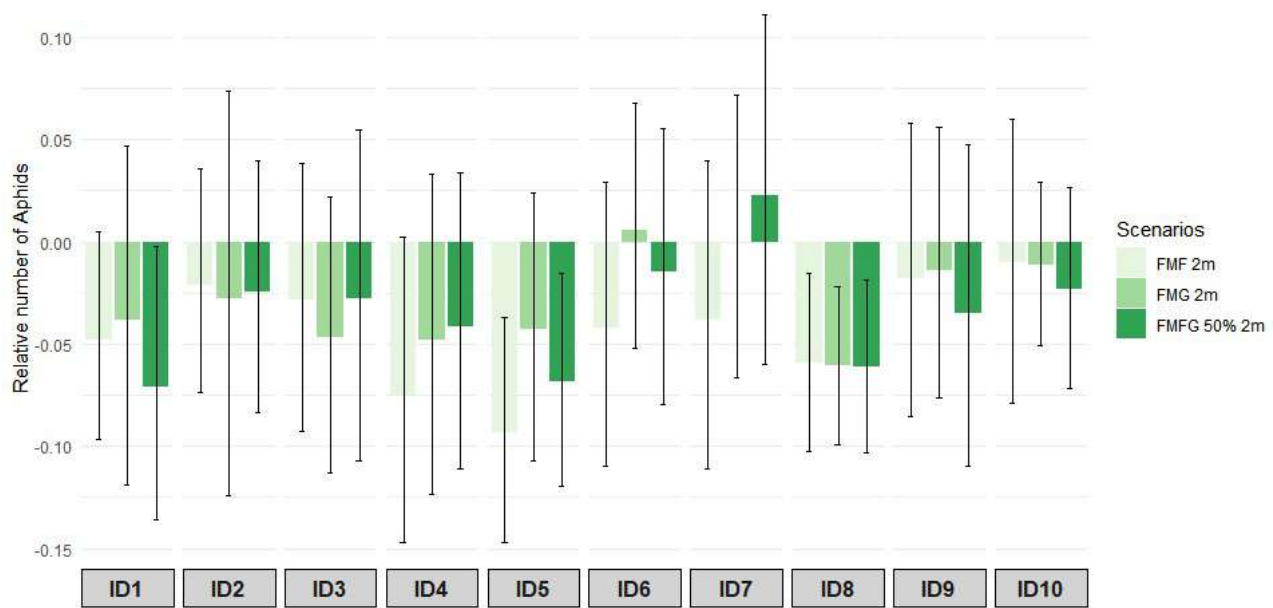


Figure 7.120 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

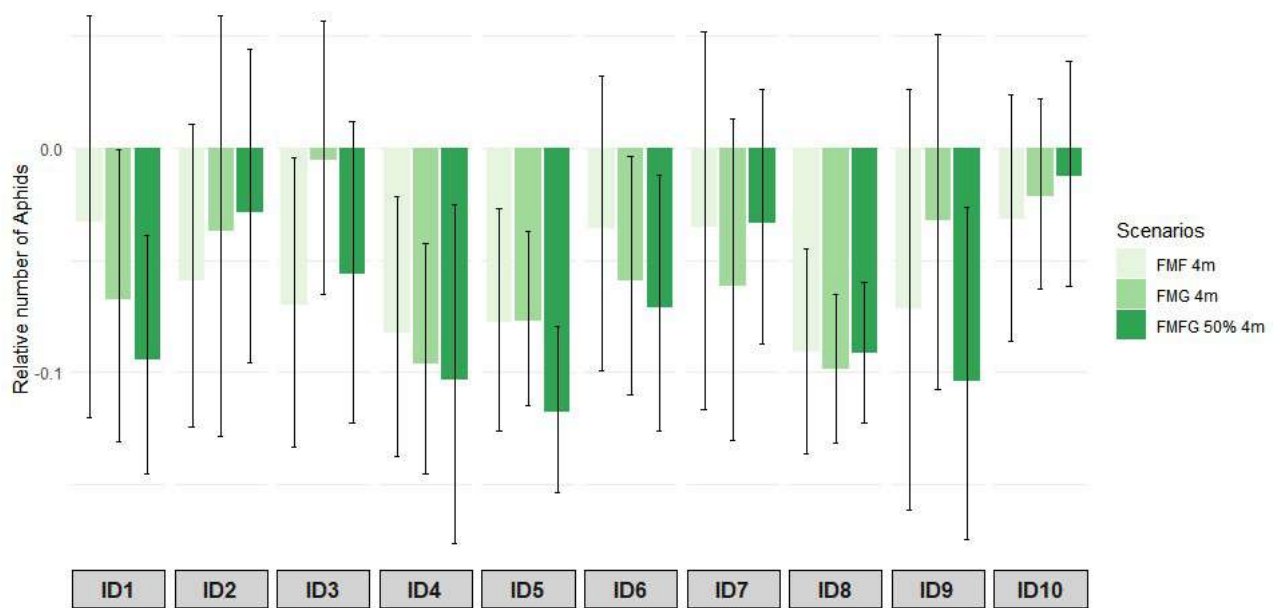


Figure 7.121 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

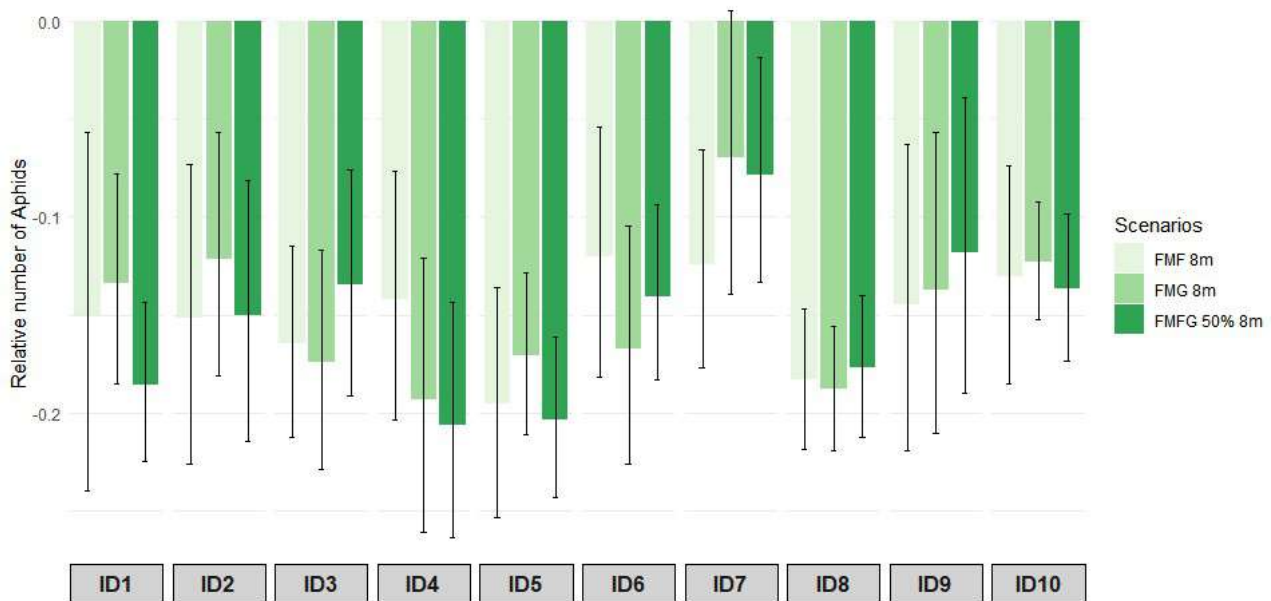


Figure 7.122 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.5.3 In-field relative to landscape

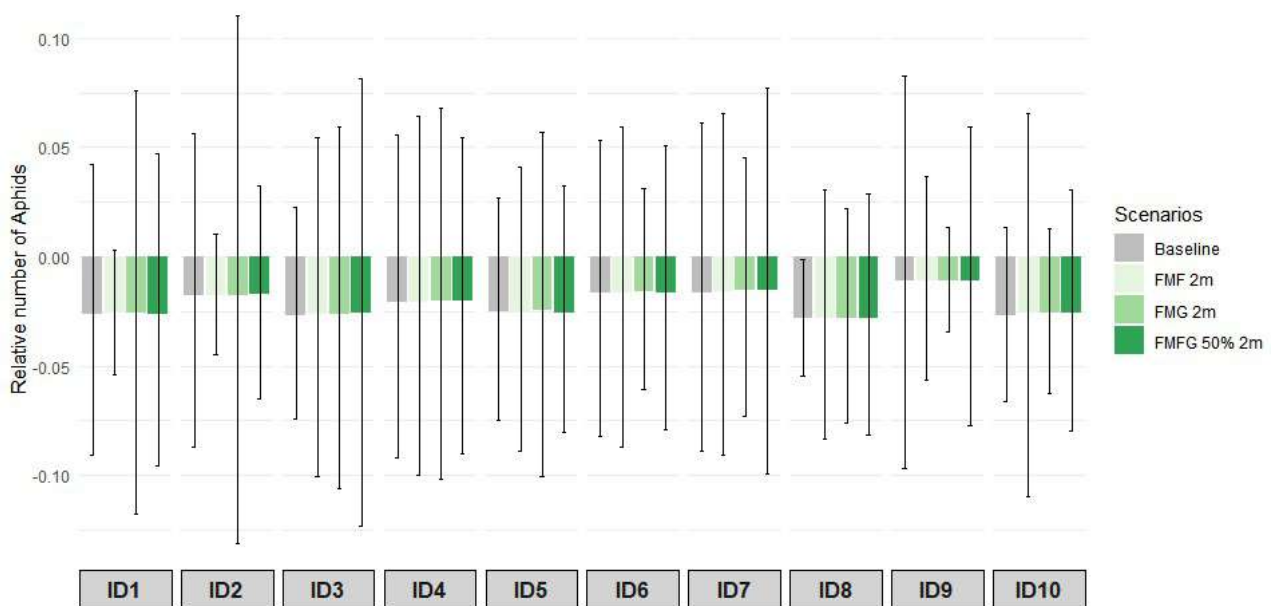


Figure 7.123 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

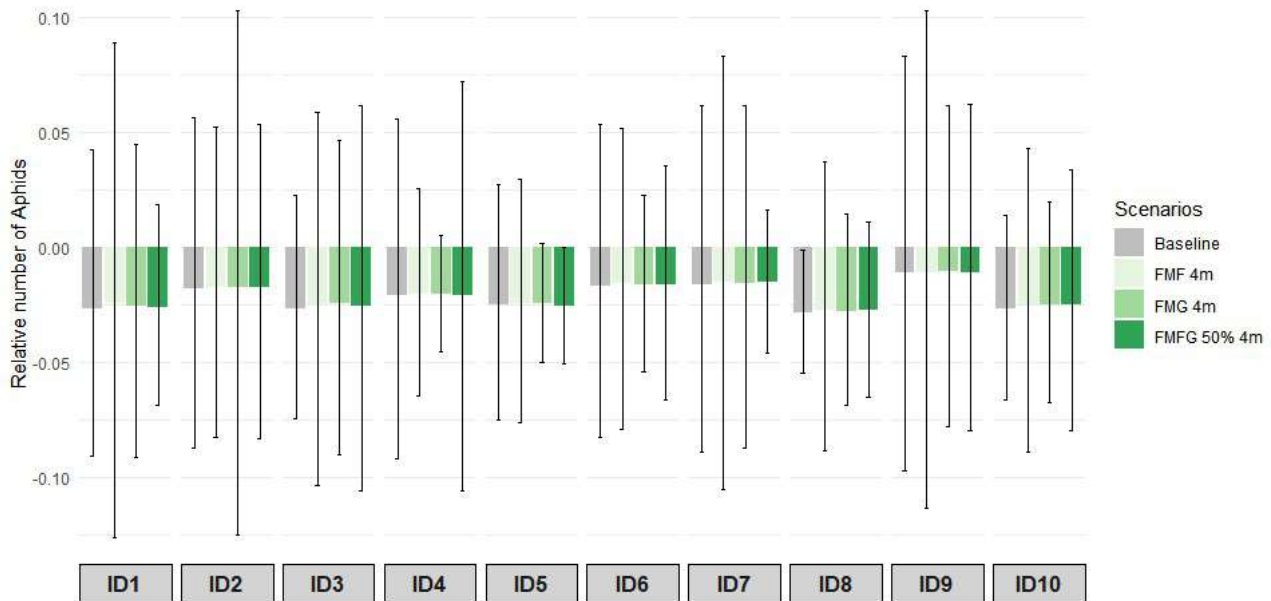


Figure 7.124 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

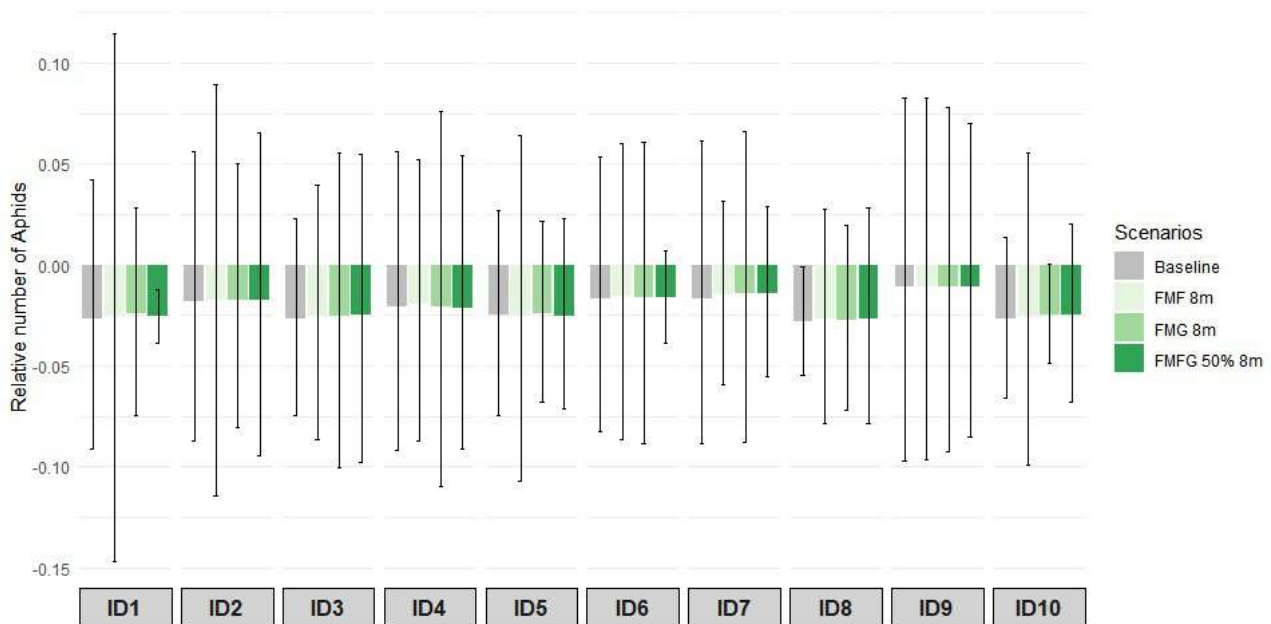


Figure 7.125 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.6 Setaside

7.7.6.1 Whole landscape

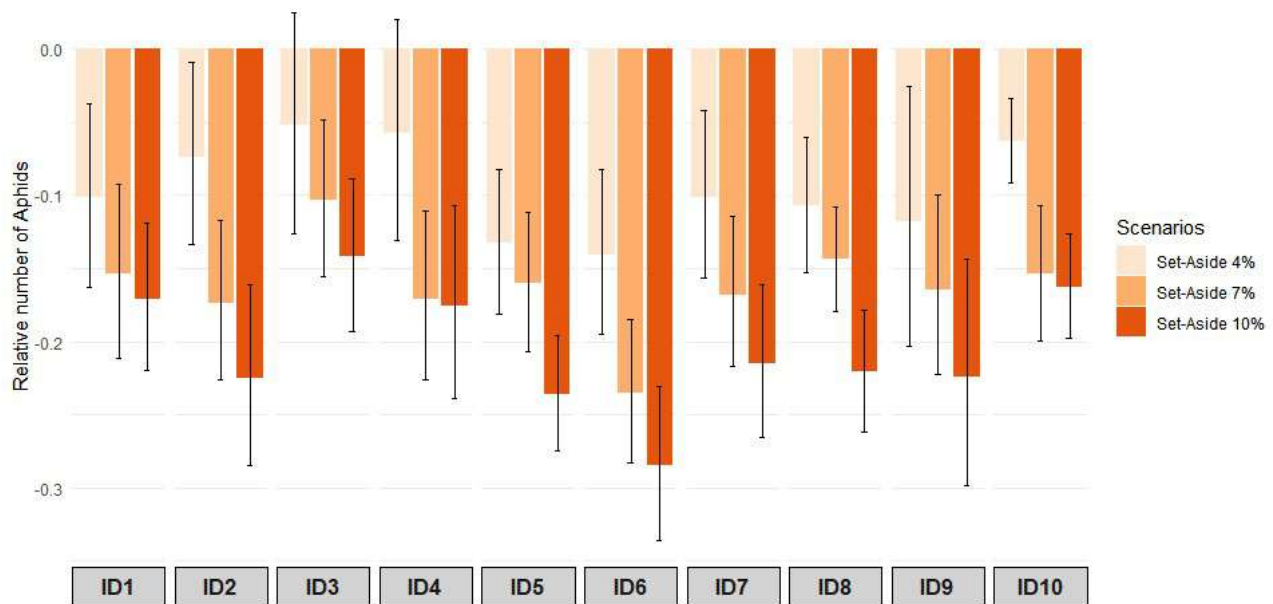


Figure 7.126 Setaside scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.6.2 In-field

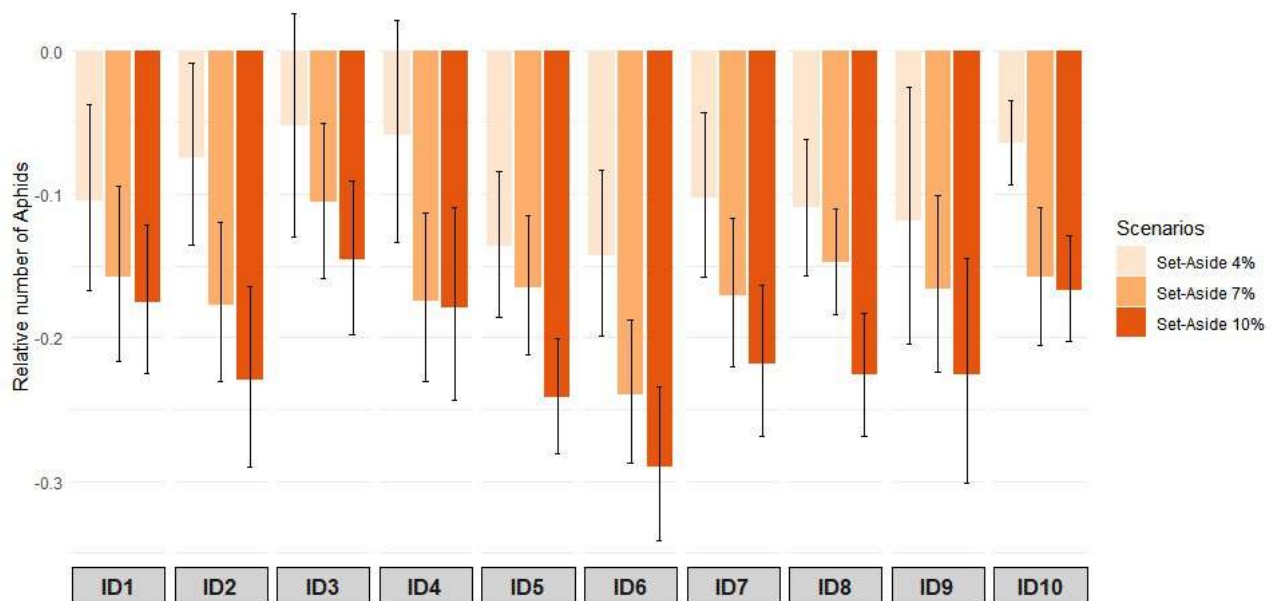


Figure 7.127 Setaside scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.6.3 In-field relative to landscape

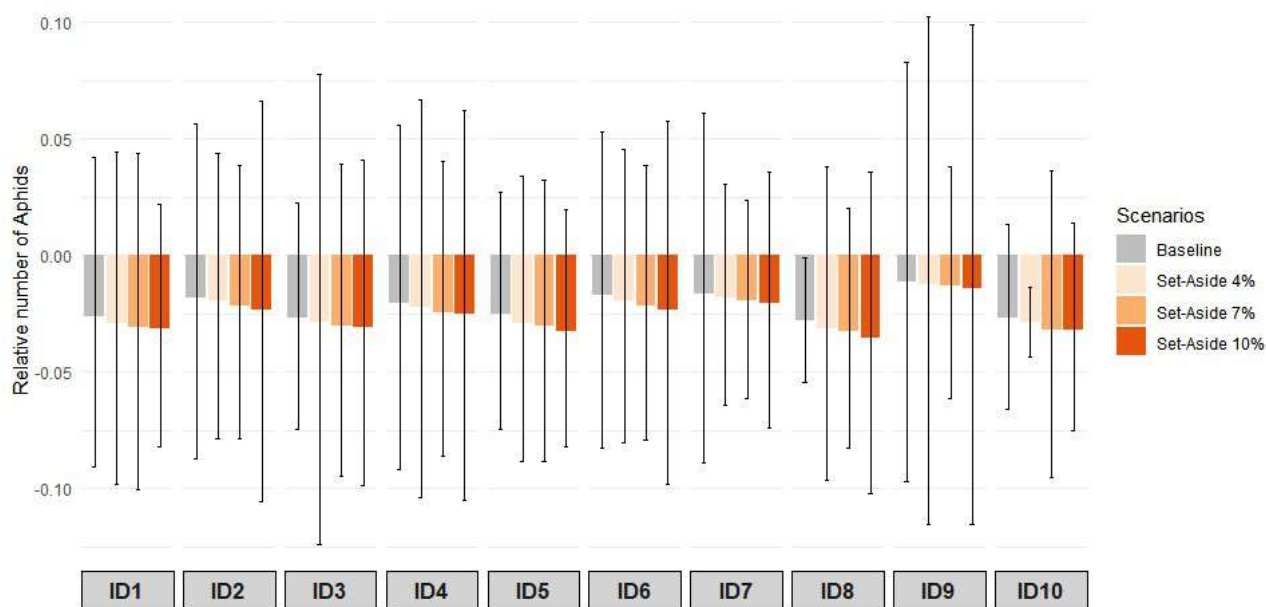


Figure 7.128 Setaside scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.7 Legume

7.7.7.1 Whole landscape

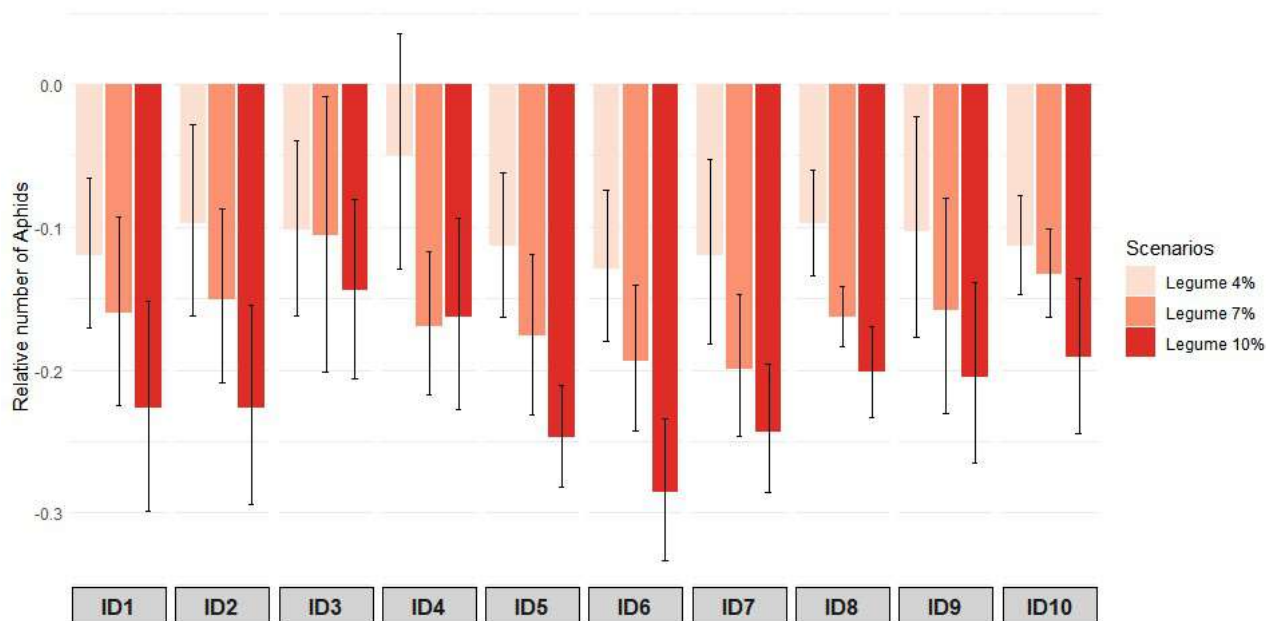


Figure 7.129 Legume scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.7.2 In-field

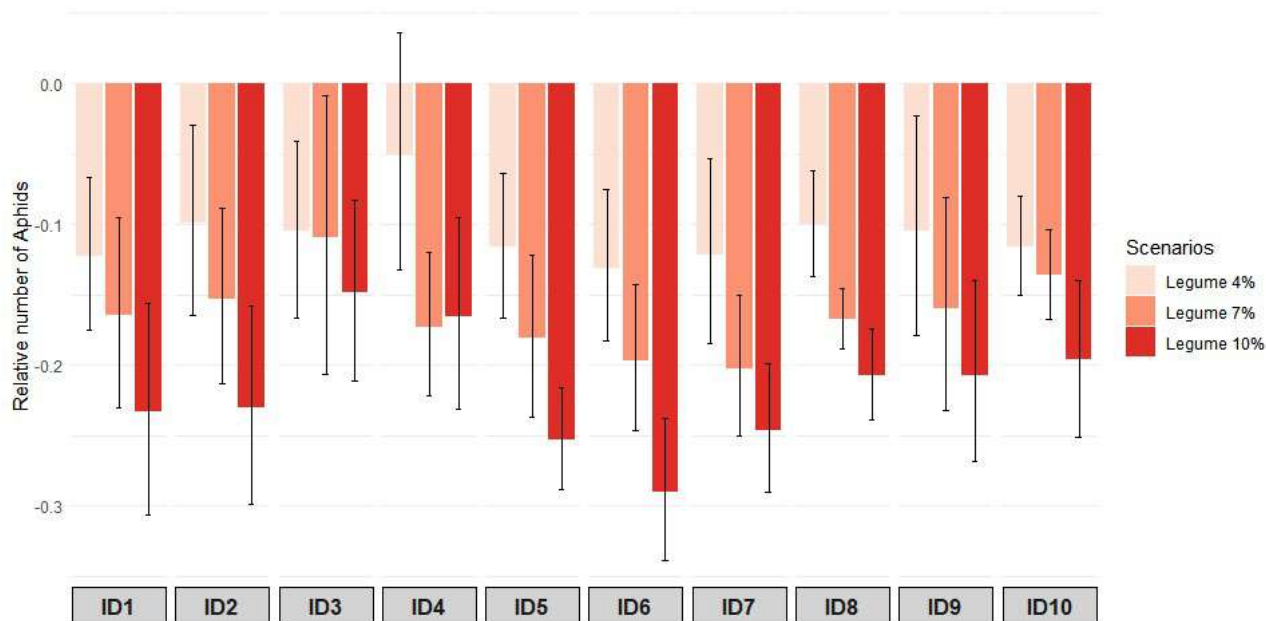


Figure 7.130 Legume scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.7.3 In-field relative to landscape

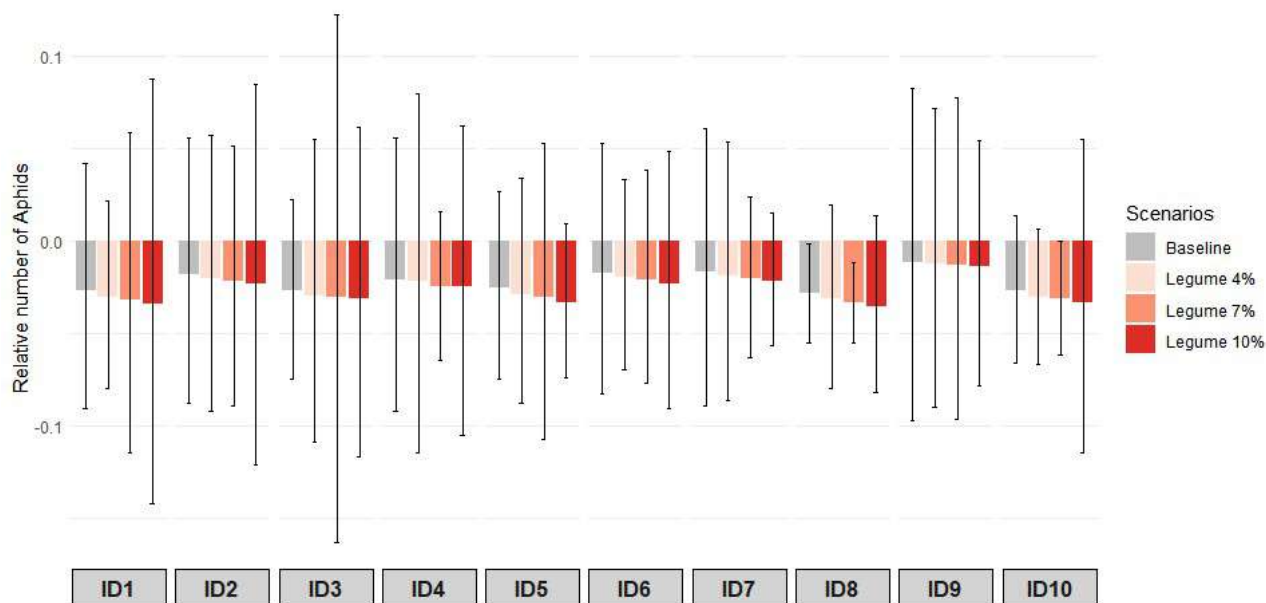


Figure 7.131 Legume scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.7.8 Biopesticides

7.7.8.1 Whole landscape

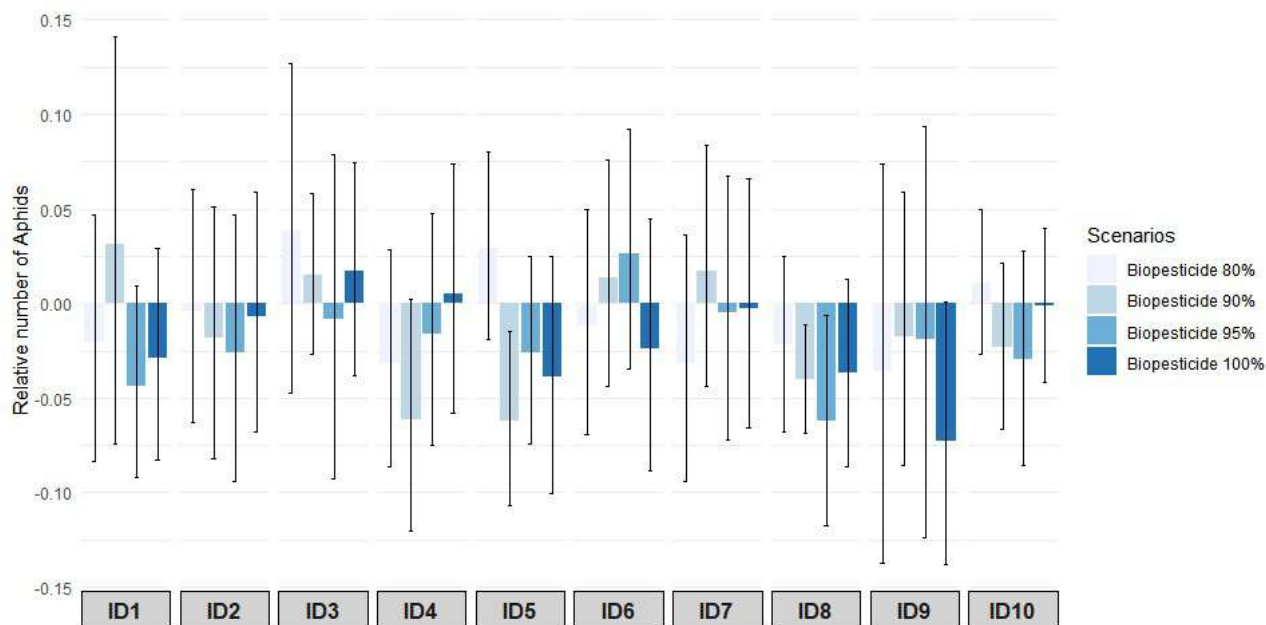


Figure 7.132 Biopesticide scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.7.8.2 In-field

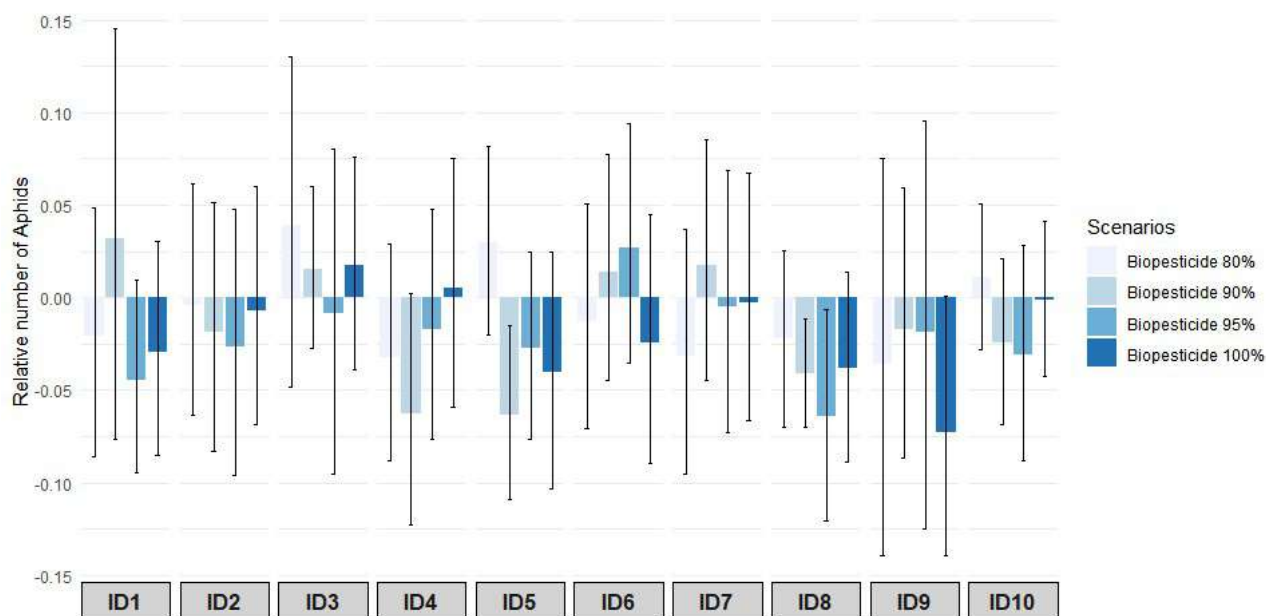


Figure 7.133 Biopesticide scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.7.8.3 In-field relative to landscape

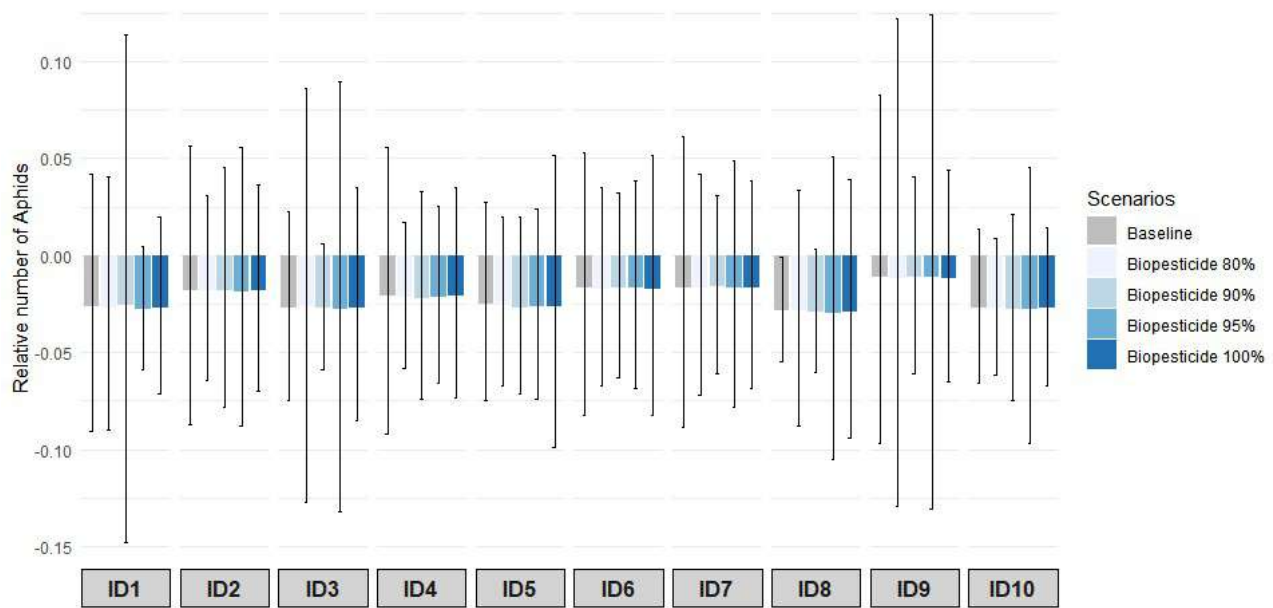


Figure 7.134 Biopesticide scenario with relative change in the number of female English grain aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.8 Combined landscapes

7.8.1 Crop diversification

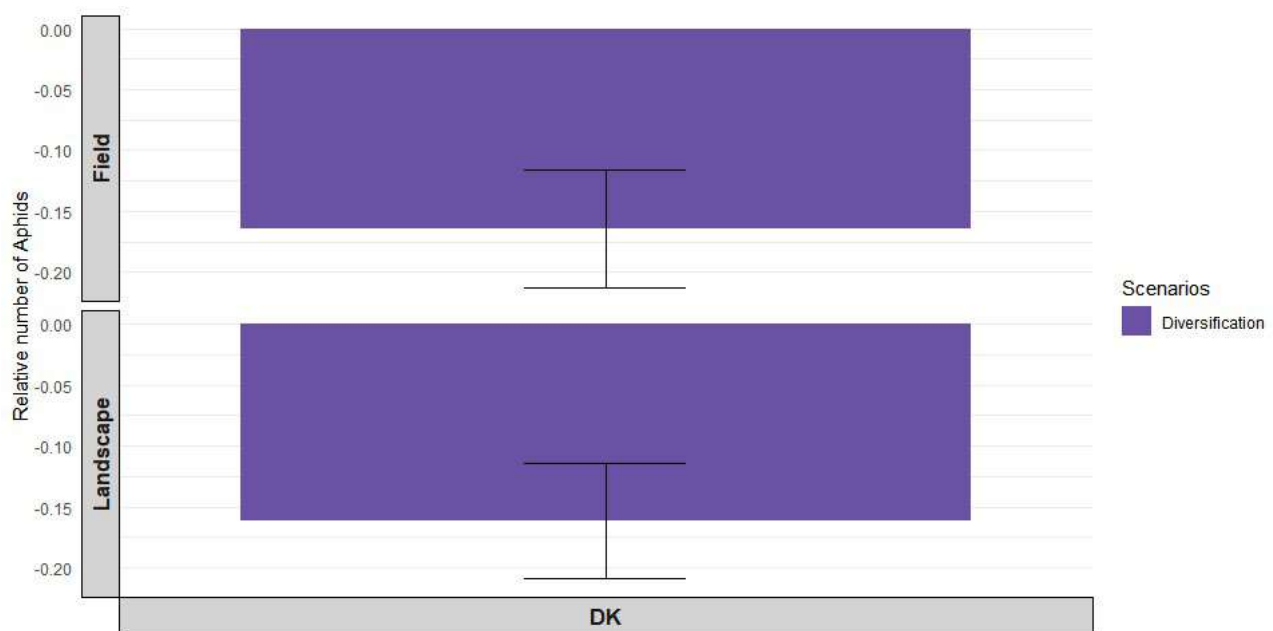


Figure 7.135 Diversification scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Denmark.

7.8.2 Flower field margins

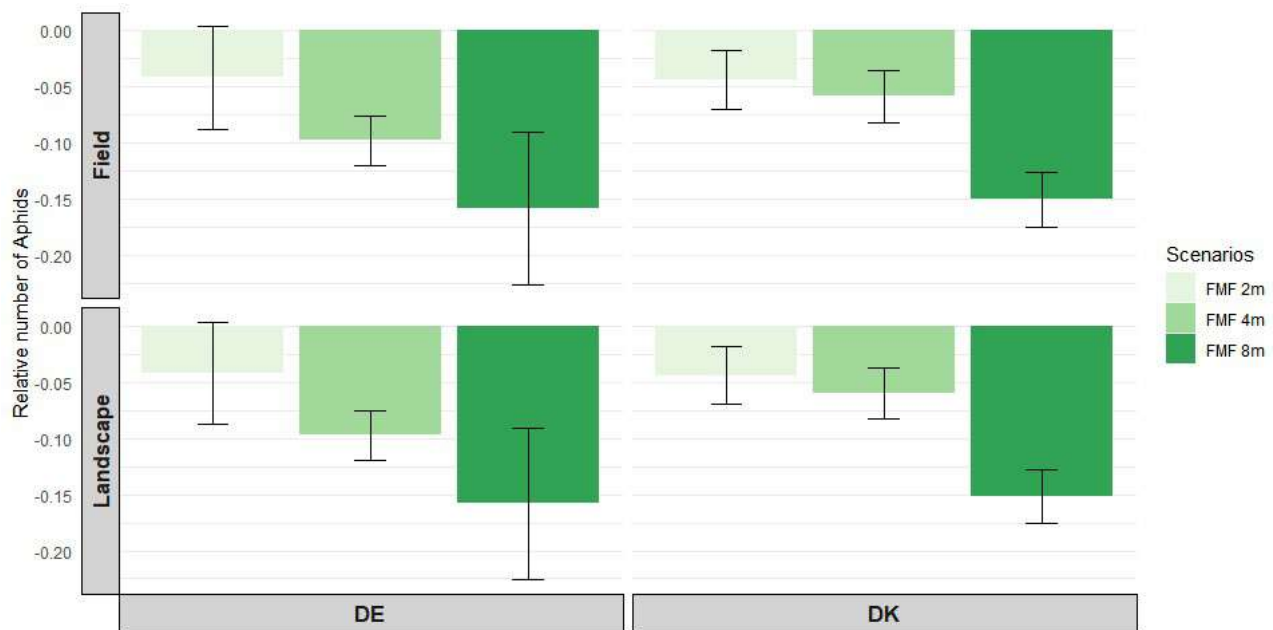


Figure 7.136 Flower field margins with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.8.3 Grass field margins

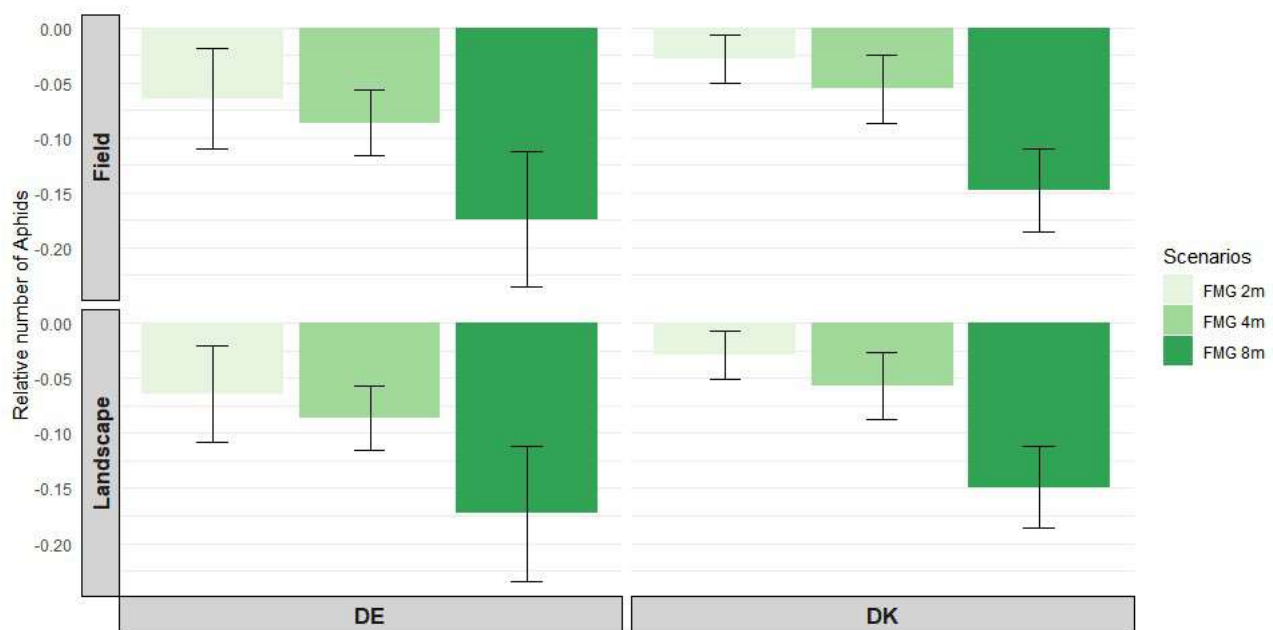


Figure 7.137 Grassy field margins with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.8.4 Mixed field margins

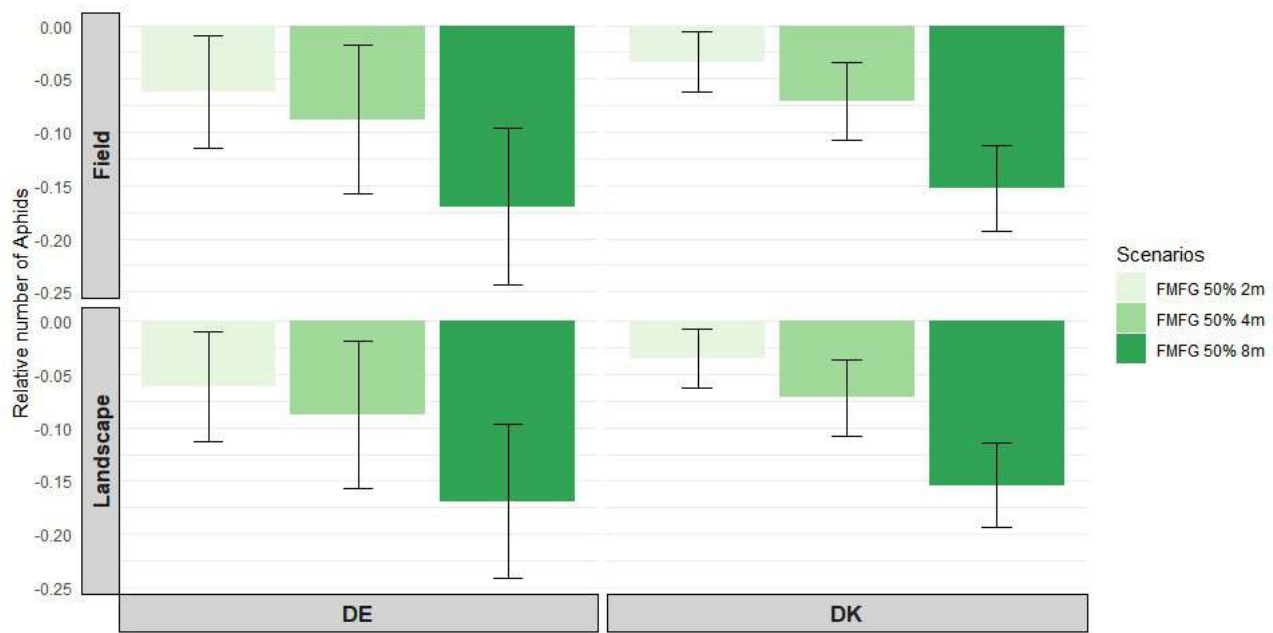


Figure 7.138 Mixed field margins with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.8.5 Flower, grassy and mixed margins

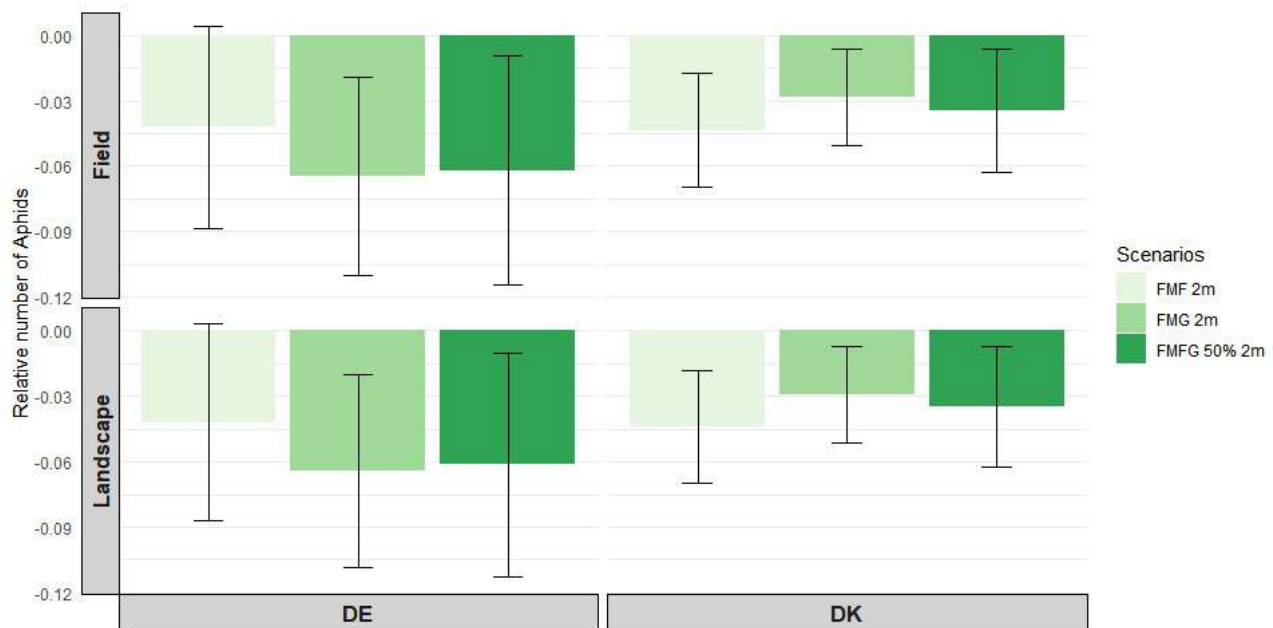


Figure 7.139 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

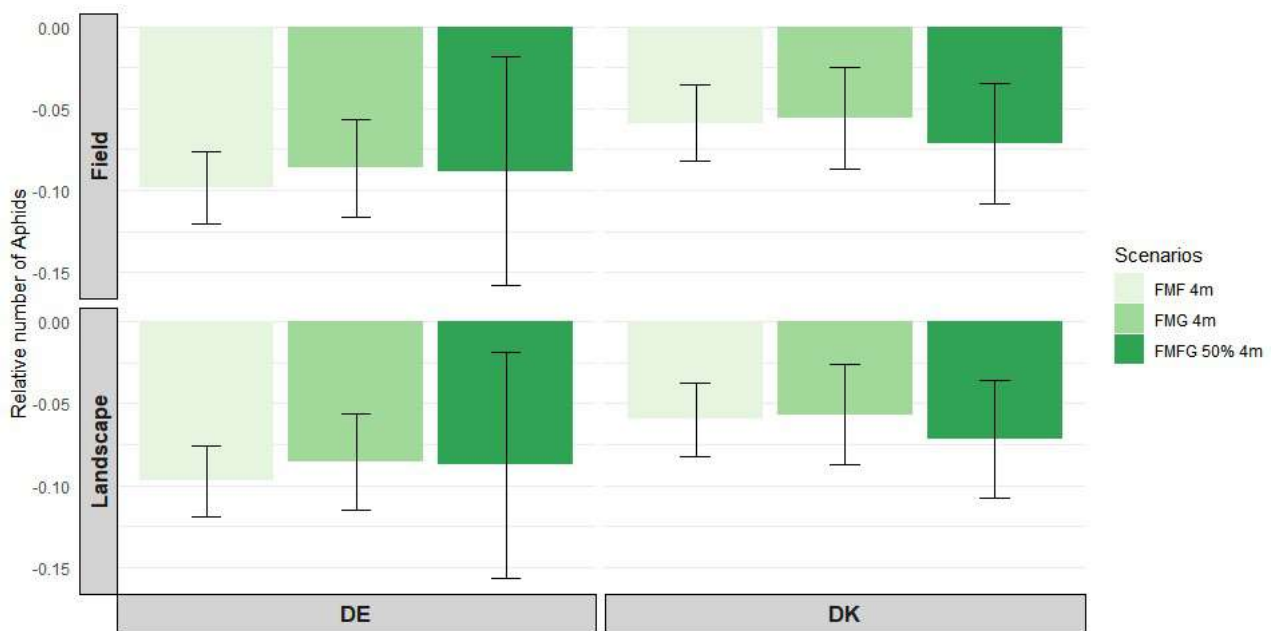


Figure 7.140 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

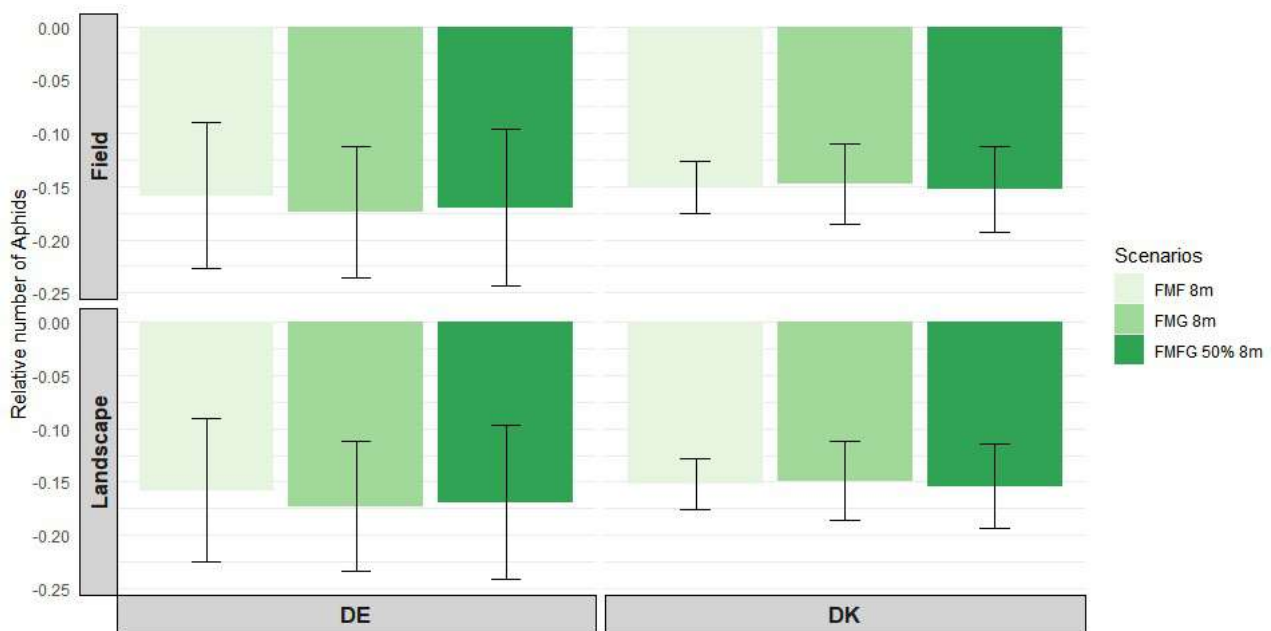


Figure 7.141 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

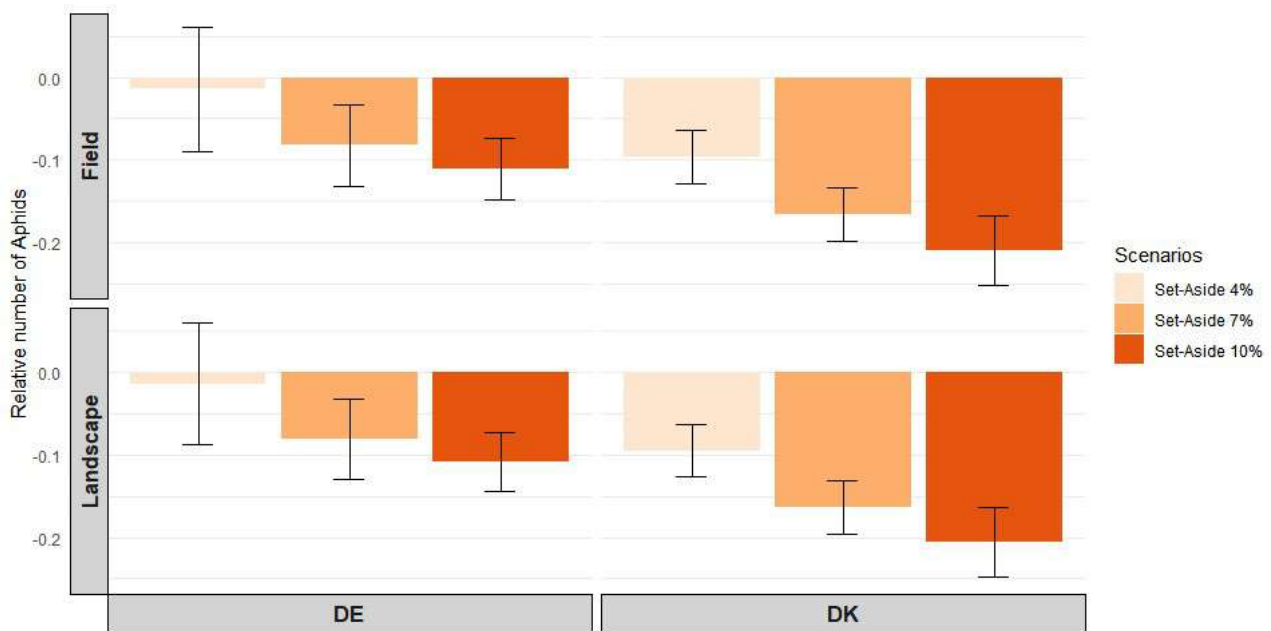


Figure 7.142 Setaside scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.8.7 Legume

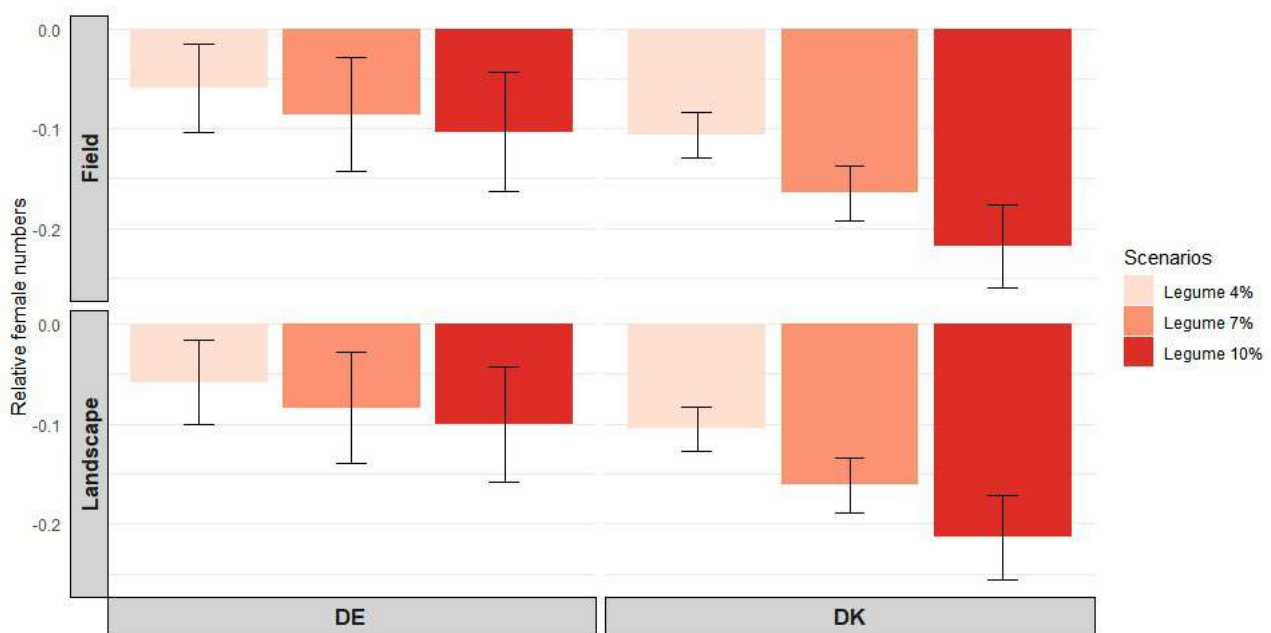


Figure 7.143 Legume scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.8.8 Biopesticides

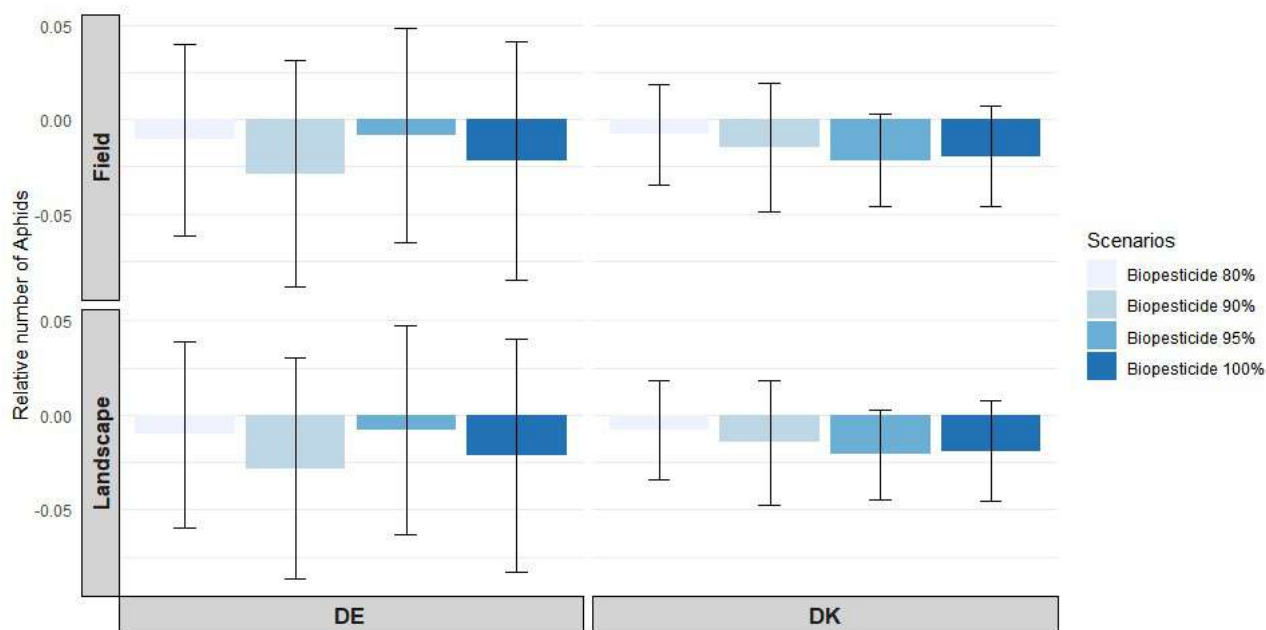


Figure 7.144 Biopesticide scenario with relative change in the number of female English grain aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.8.9 Table of relative change compared to baseline scenarios

Table 7.2 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for English grain aphids. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scale	Scenario	DK	DE
Field	Diversification	-16% (SD 5%)	NA
Landscape	Diversification	-16% (SD 5%)	NA
Field	FMF 2m	-4% (SD 3%)	-4% (SD 5%)
Field	FMF 4m	-6% (SD 2%)	-10% (SD 2%)
Field	FMF 8m	-15% (SD 2%)	-16% (SD 7%)
Landscape	FMF 2m	-4% (SD 3%)	-4% (SD 5%)
Landscape	FMF 4m	-6% (SD 2%)	-10% (SD 2%)
Landscape	FMF 8m	-15% (SD 2%)	-16% (SD 7%)
Field	FMG 2m	-3% (SD 2%)	-6% (SD 5%)
Field	FMG 4m	-6% (SD 3%)	-9% (SD 3%)
Field	FMG 8m	-15% (SD 4%)	-17% (SD 6%)
Landscape	FMG 2m	-3% (SD 2%)	-6% (SD 4%)

Scale	Scenario	DK	DE
Landscape	FMG 4m	-6% (SD 3%)	-9% (SD 3%)
Landscape	FMG 8m	-15% (SD 4%)	-17% (SD 6%)
Field	FMFG 50% 2m	-3% (SD 3%)	-6% (SD 5%)
Field	FMFG 50% 4m	-7% (SD 4%)	-9% (SD 7%)
Field	FMFG 50% 8m	-15% (SD 4%)	-17% (SD 7%)
Landscape	FMFG 50% 2m	-3% (SD 3%)	-6% (SD 5%)
Landscape	FMFG 50% 4m	-7% (SD 4%)	-9% (SD 7%)
Landscape	FMFG 50% 8m	-15% (SD 4%)	-17% (SD 7%)
Field	Set-Aside 4%	-10% (SD 3%)	-1% (SD 8%)
Field	Set-Aside 7%	-17% (SD 3%)	-8% (SD 5%)
Field	Set-Aside 10%	-21% (SD 4%)	-11% (SD 4%)
Landscape	Set-Aside 4%	-9% (SD 3%)	-1% (SD 7%)
Landscape	Set-Aside 7%	-16% (SD 3%)	-8% (SD 5%)
Landscape	Set-Aside 10%	-21% (SD 4%)	-11% (SD 4%)
Field	Legume 4%	-11% (SD 2%)	-6% (SD 4%)
Field	Legume 7%	-16% (SD 3%)	-9% (SD 6%)
Field	Legume 10%	-22% (SD 4%)	-10% (SD 6%)
Landscape	Legume 4%	-10% (SD 2%)	-6% (SD 4%)
Landscape	Legume 7%	-16% (SD 3%)	-8% (SD 6%)
Landscape	Legume 10%	-21% (SD 4%)	-10% (SD 6%)
Field	Biopesticide 80%	-1% (SD 3%)	-1% (SD 5%)
Field	Biopesticide 90%	-1% (SD 3%)	-3% (SD 6%)
Field	Biopesticide 95%	-2% (SD 2%)	-1% (SD 6%)
Field	Biopesticide 100%	-2% (SD 3%)	-2% (SD 6%)
Landscape	Biopesticide 80%	-1% (SD 3%)	-1% (SD 5%)
Landscape	Biopesticide 90%	-1% (SD 3%)	-3% (SD 6%)
Landscape	Biopesticide 95%	-2% (SD 2%)	-1% (SD 6%)
Landscape	Biopesticide 100%	-2% (SD 3%)	-2% (SD 6%)

7.C PEA APHID

7.9 Baselines across countries

7.9.1 Whole landscape

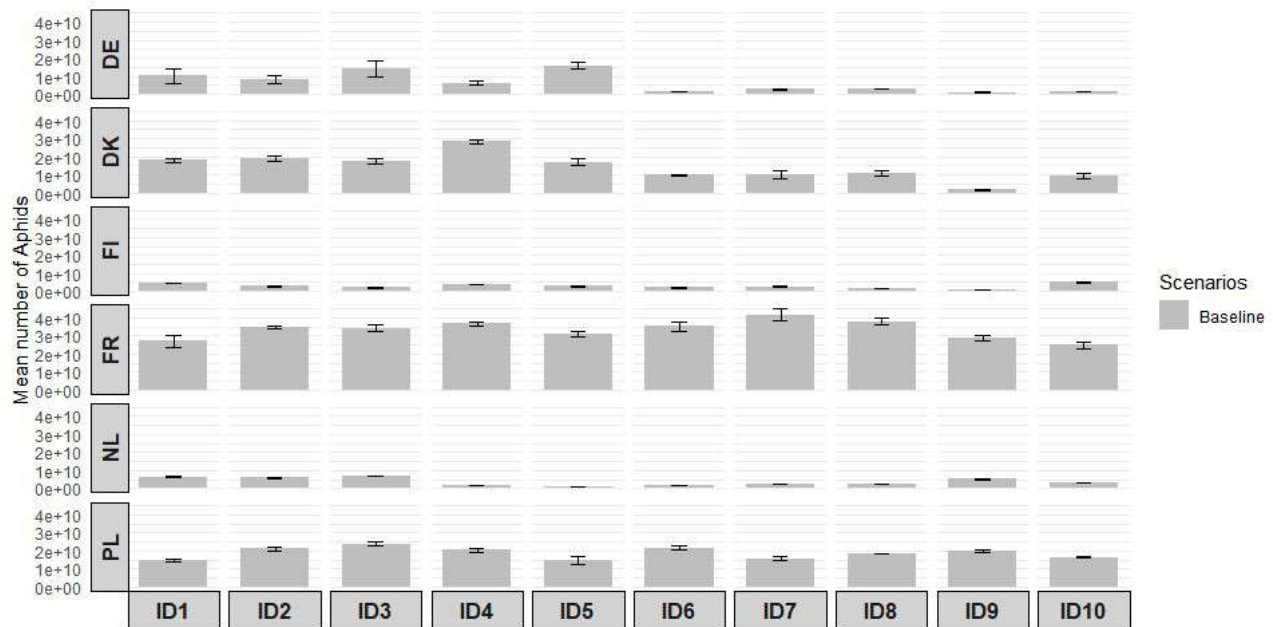


Figure 7.145 Pea aphid baselines for each country and landscape

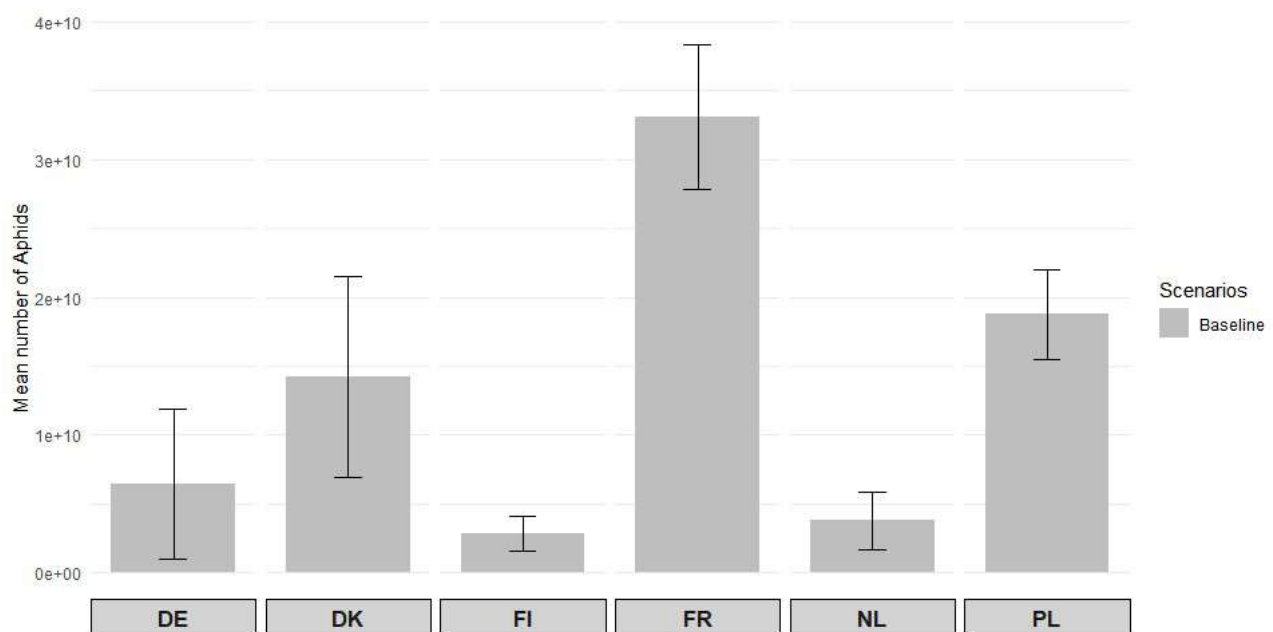


Figure 7.146 Pea aphid baselines for each country combined across landscapes.

7.9.2 In-field

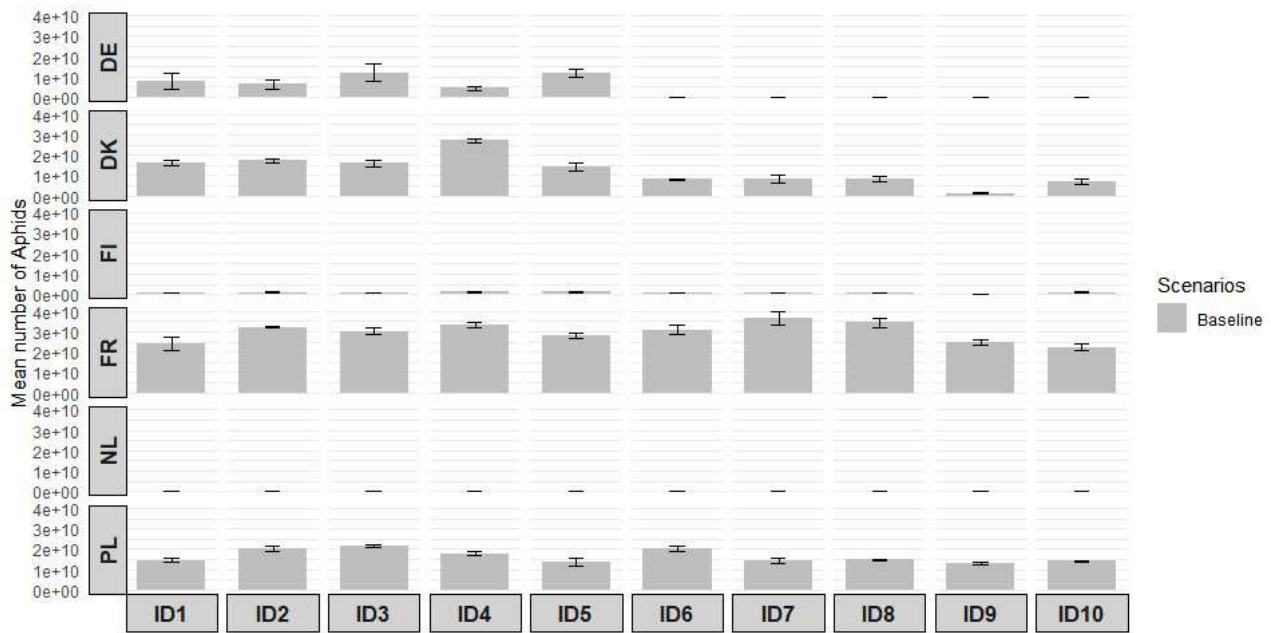


Figure 7.147 Pea aphid baselines for each country and landscape. Pea aphids in the fields only.

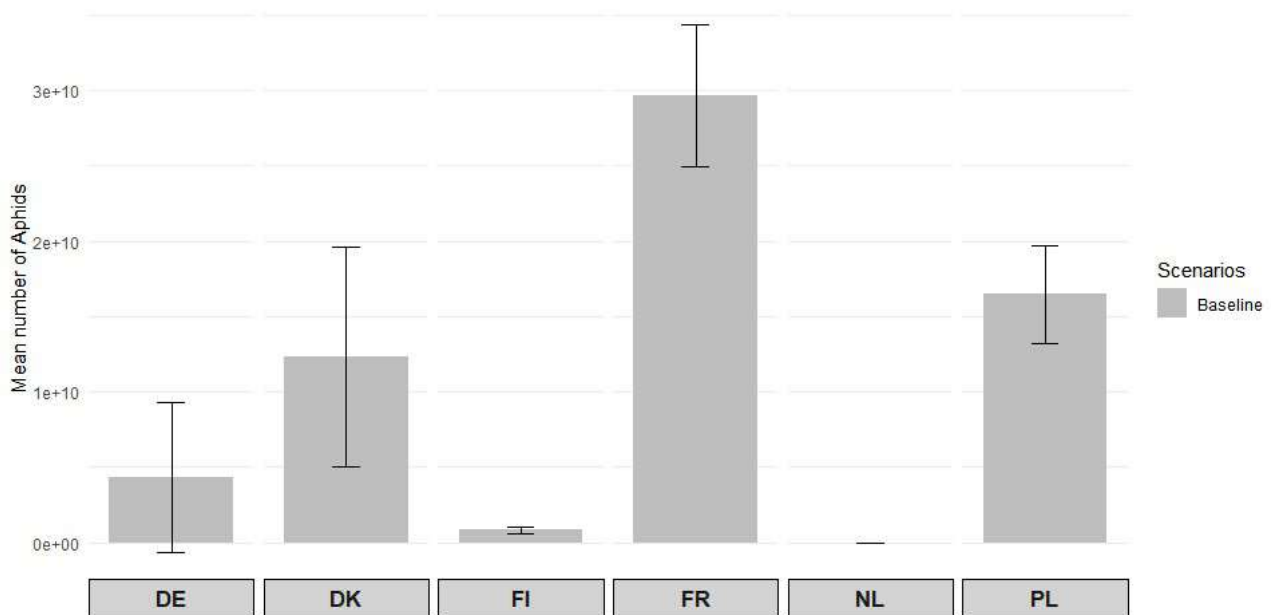


Figure 7.148 Pea aphid baselines for each country combined across landscapes. Pea aphids in the fields only.

7.9.3 In-field relative to landscape

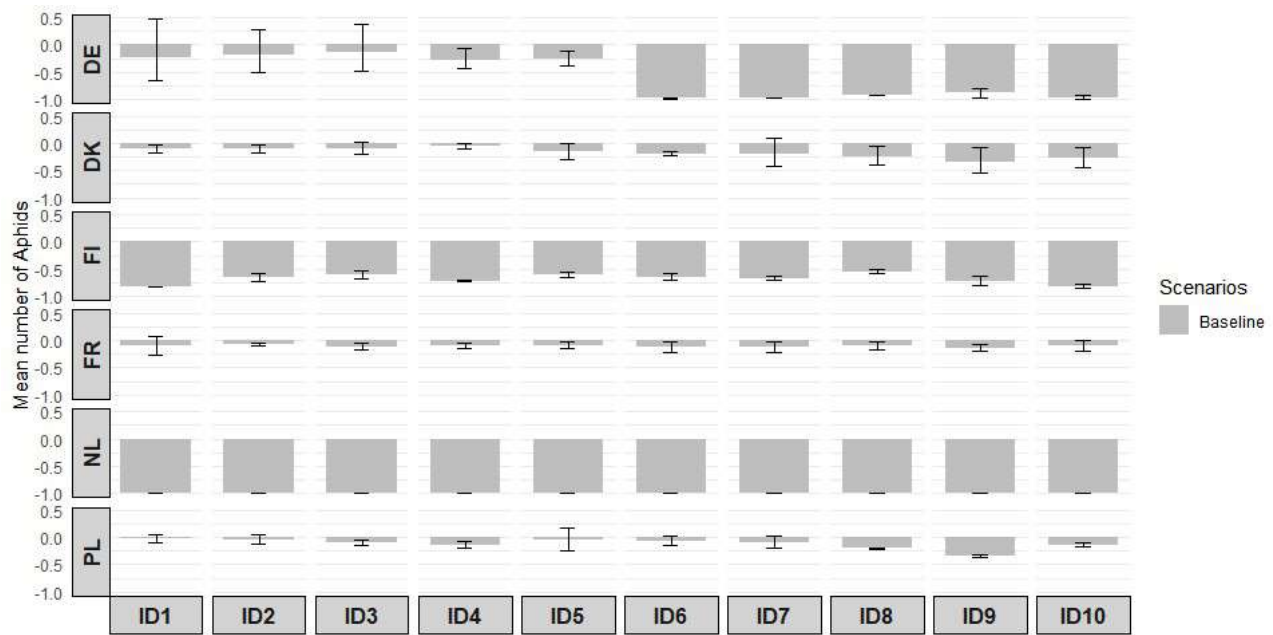


Figure 7.149 In-field relative to whole landscape comparison of Pea aphid baseline runs across countries and landscapes.

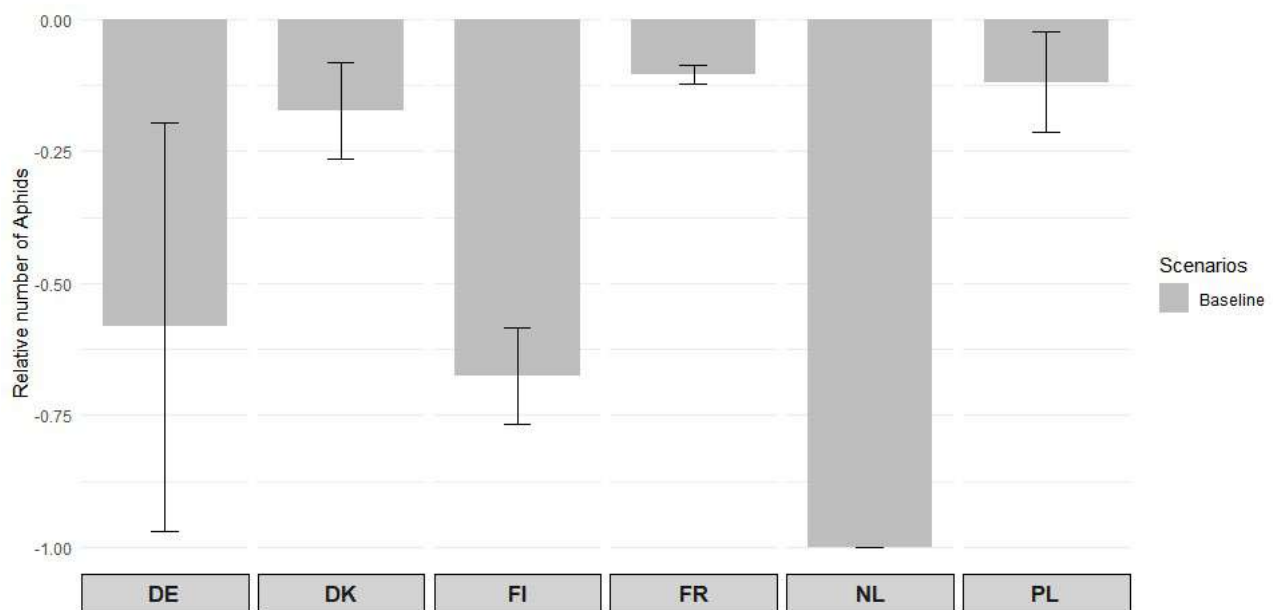


Figure 7.150 In-field relative to whole landscape comparison of Pea aphid baseline for each country across landscapes.

7.10 Germany

7.10.1 Flower field margins

7.10.1.1 Whole landscape

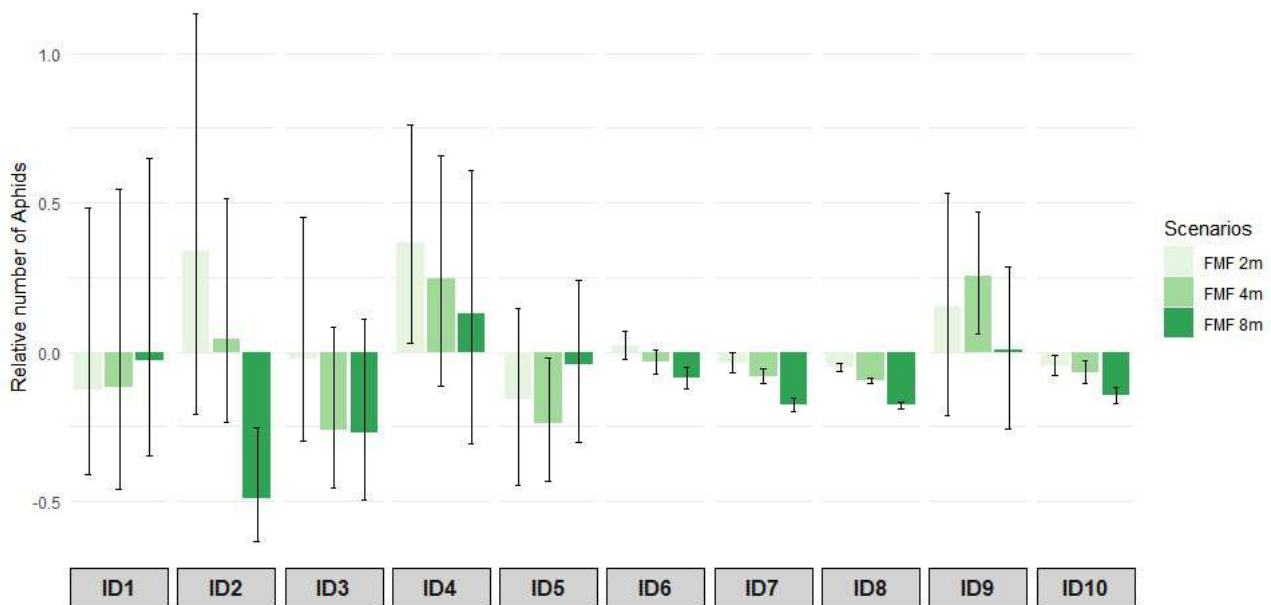


Figure 7.151 Flower field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.1.2 In-field

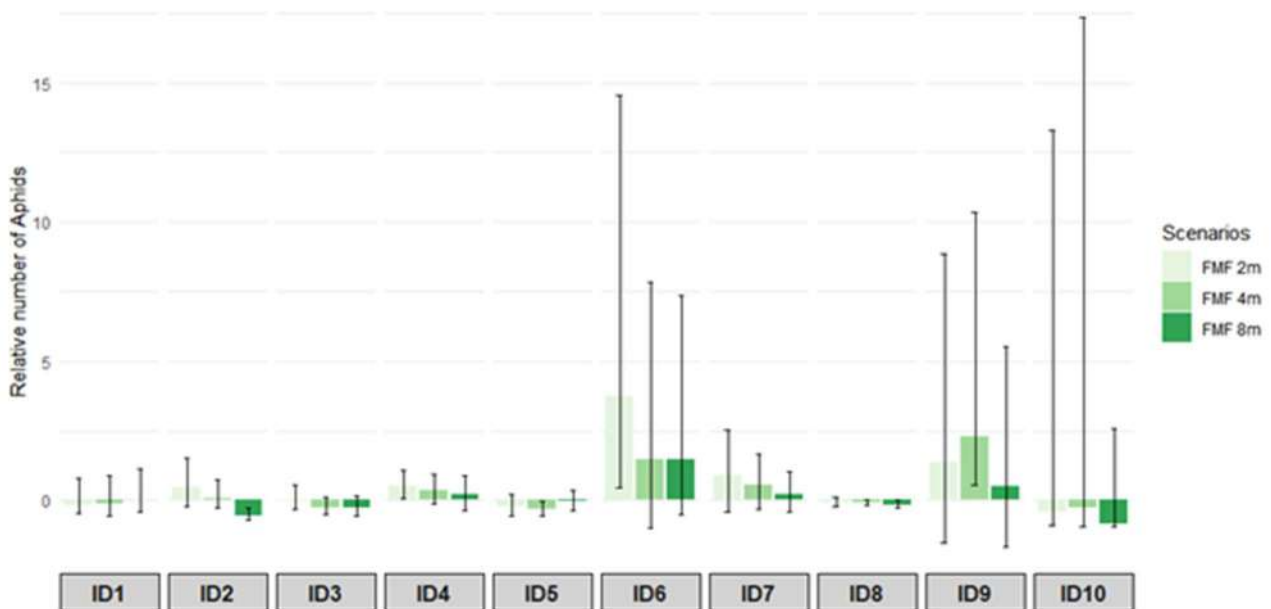


Figure 7.152 Flower field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.1.3 In-field relative to landscape

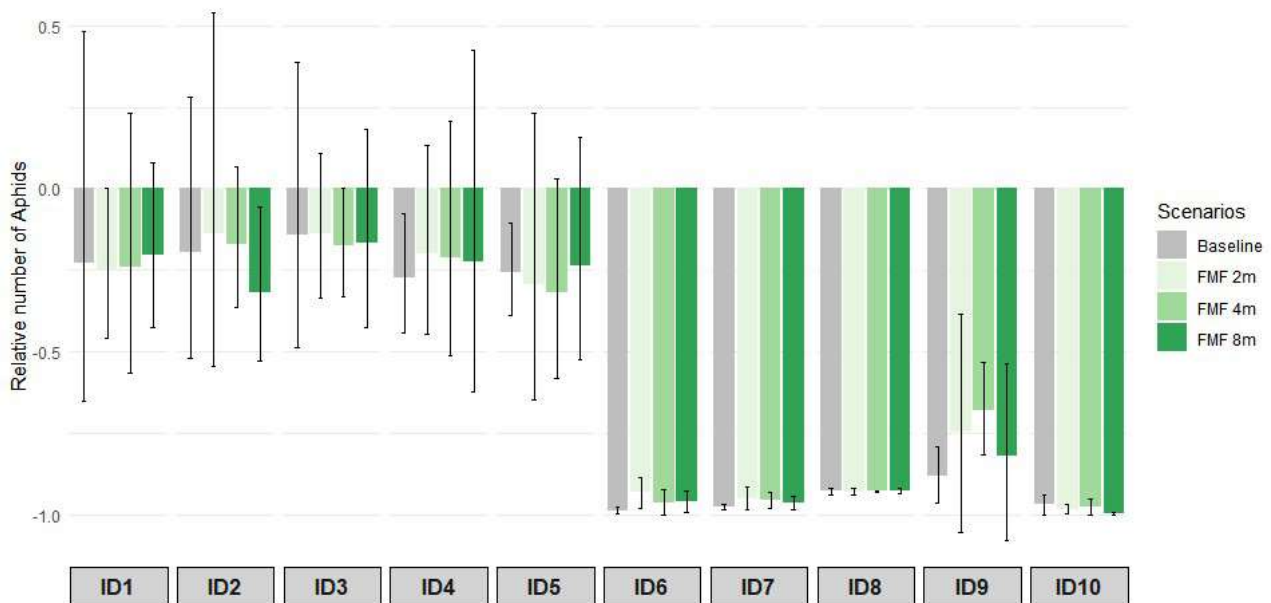


Figure 7.153 Flower field margins scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.10.2 Grass field margins

7.10.2.1 Whole landscape

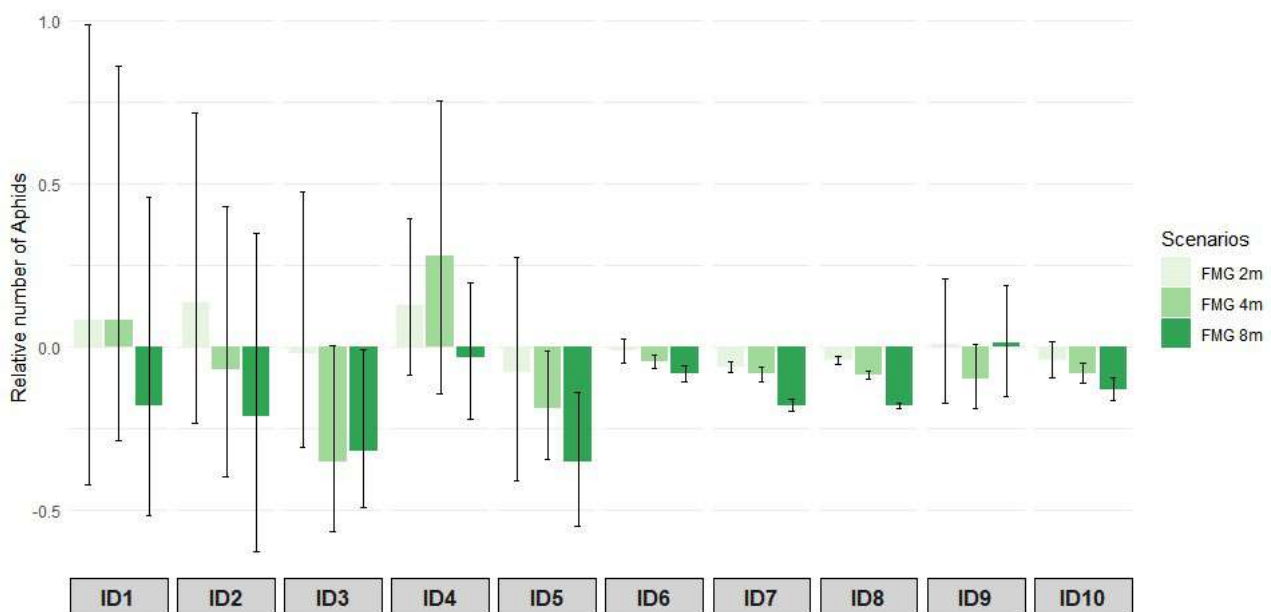


Figure 7.154 Grassy field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.2.2 In-field

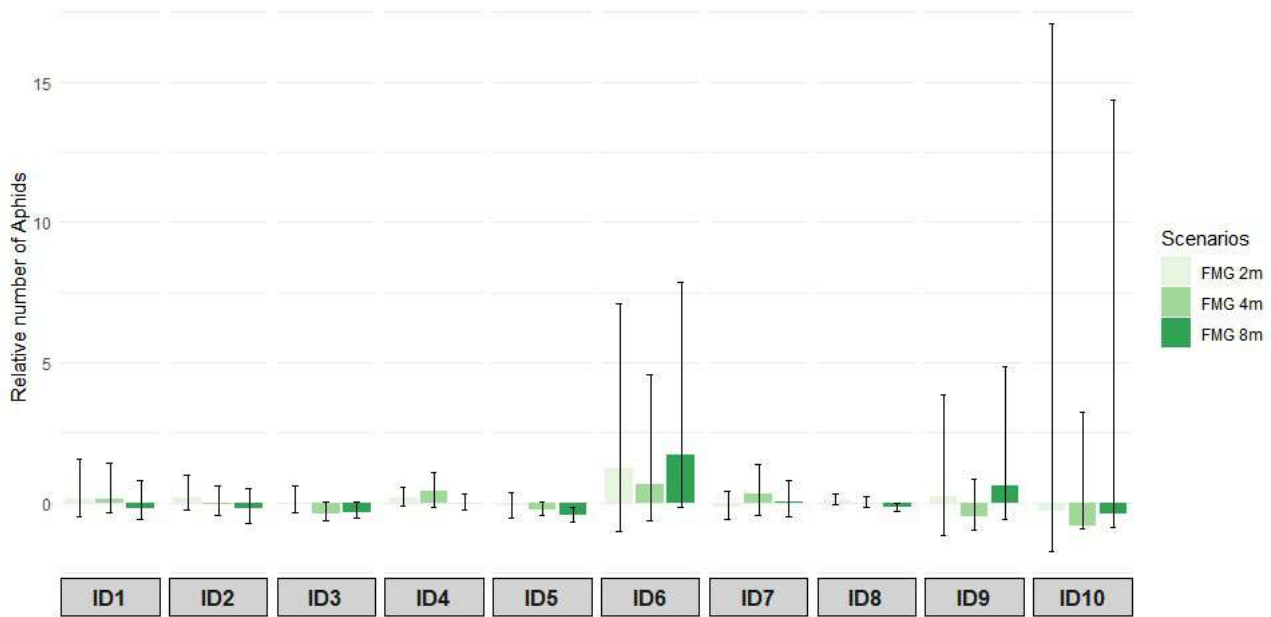


Figure 7.155 Grassy field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.2.3 In-field relative to landscape



Figure 7.156 Grassy field margins scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.10.3 Mixed field margins

7.10.3.1 Whole landscape

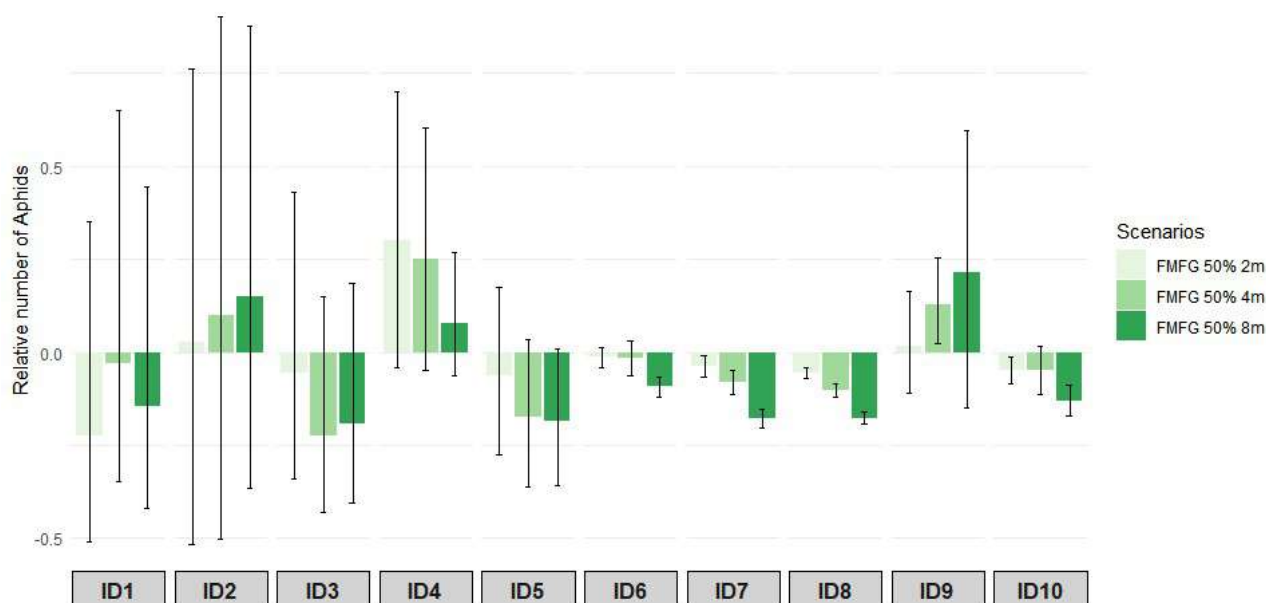


Figure 7.157 Mixed field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.3.2 In-field

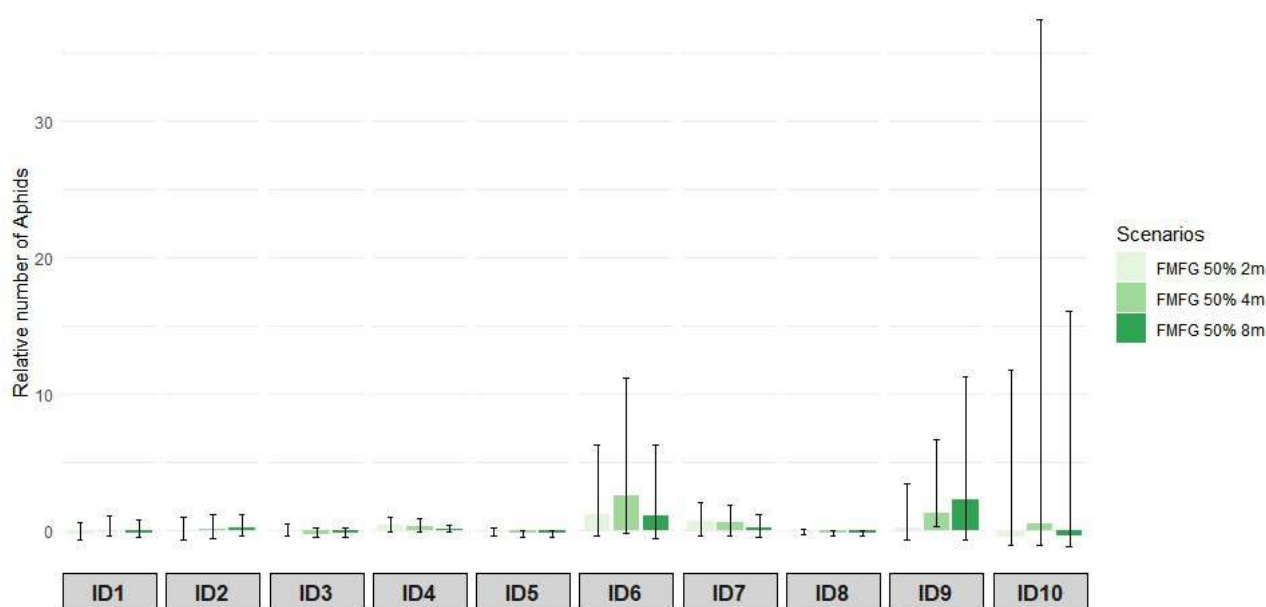


Figure 7.158 Mixed field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.3.3 In-field relative to landscape

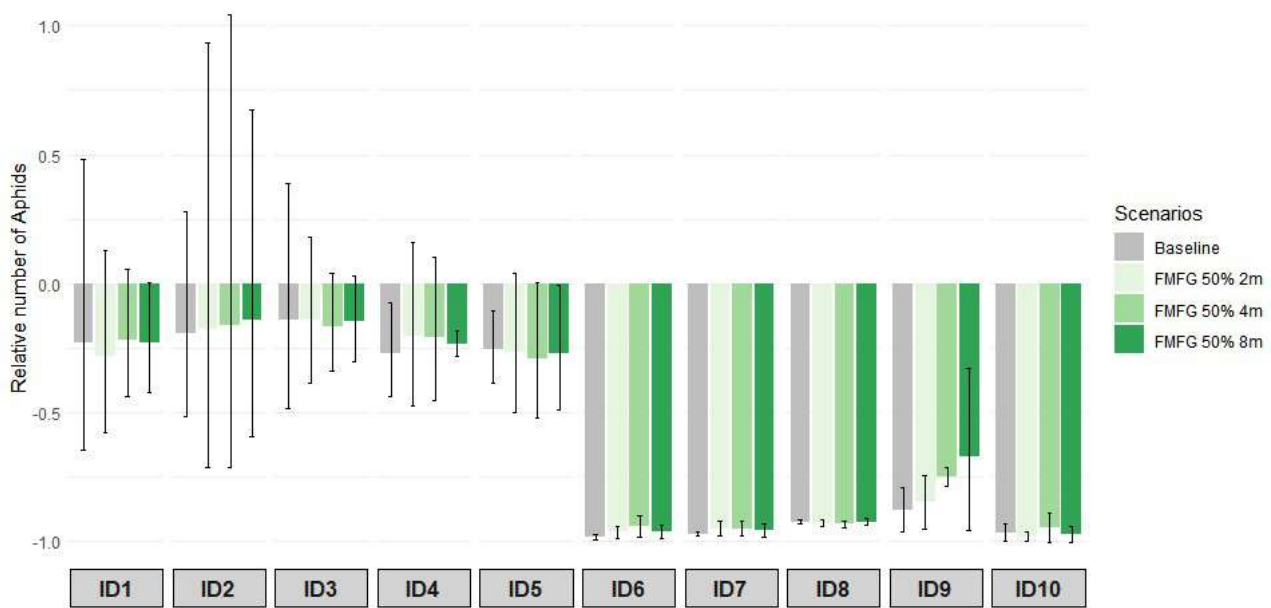


Figure 7.159 Mixed field margins scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.10.4 Flower, grassy and mixed margins

7.10.4.1 Whole landscape

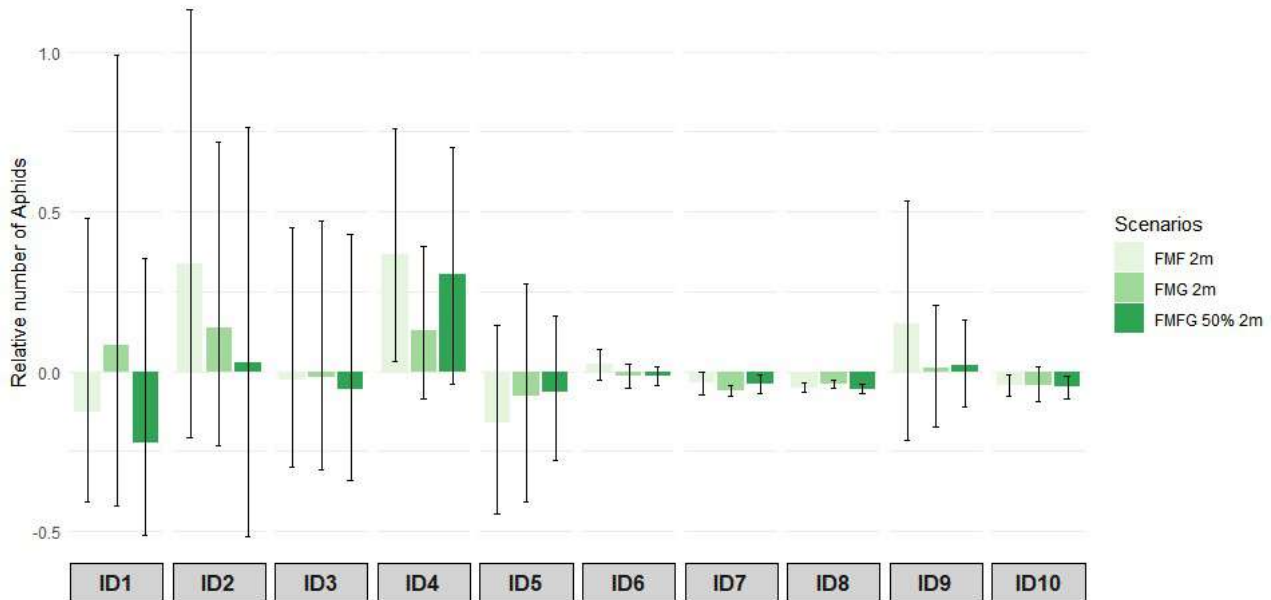


Figure 7.160 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

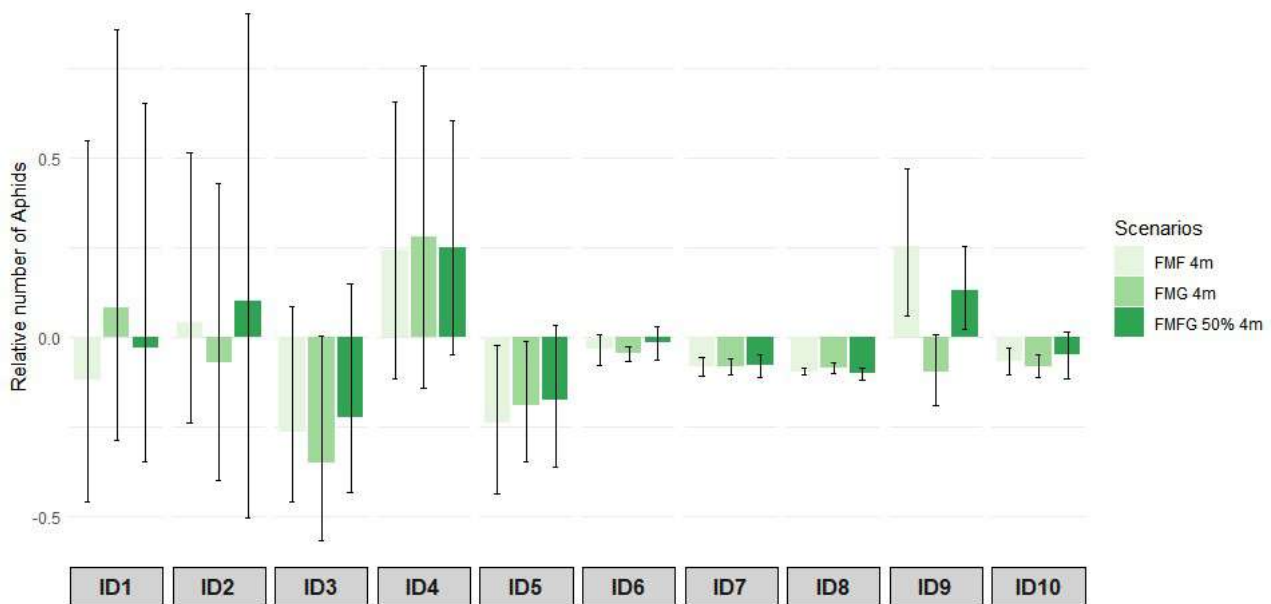


Figure 7.161 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

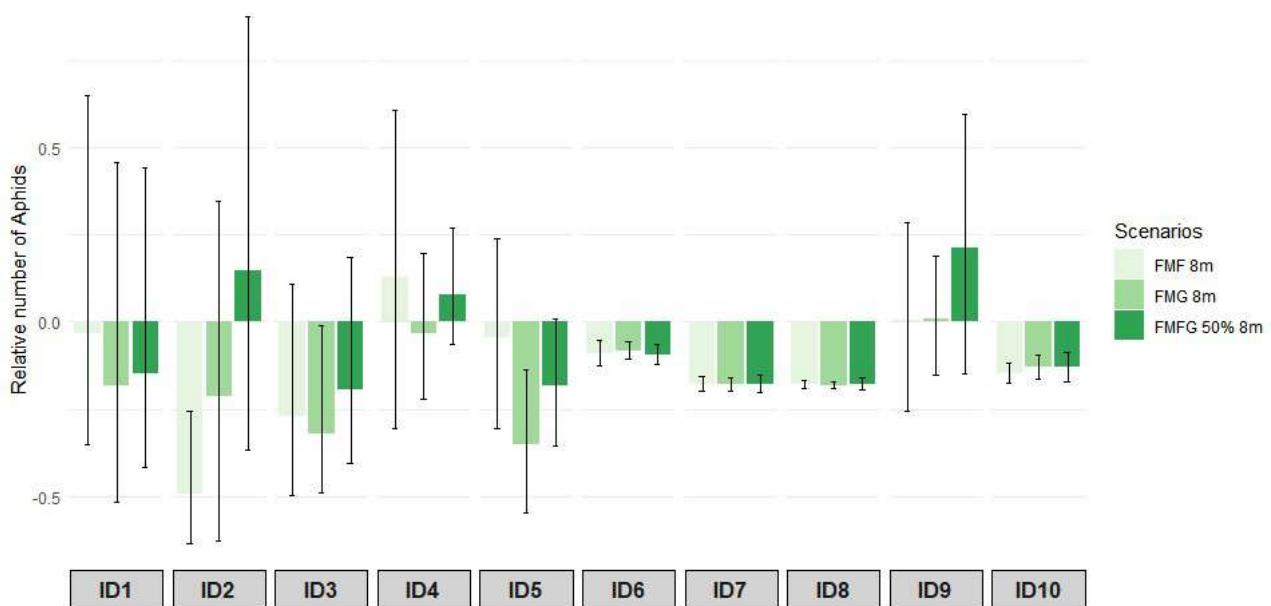


Figure 7.162 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.4.2 In-field

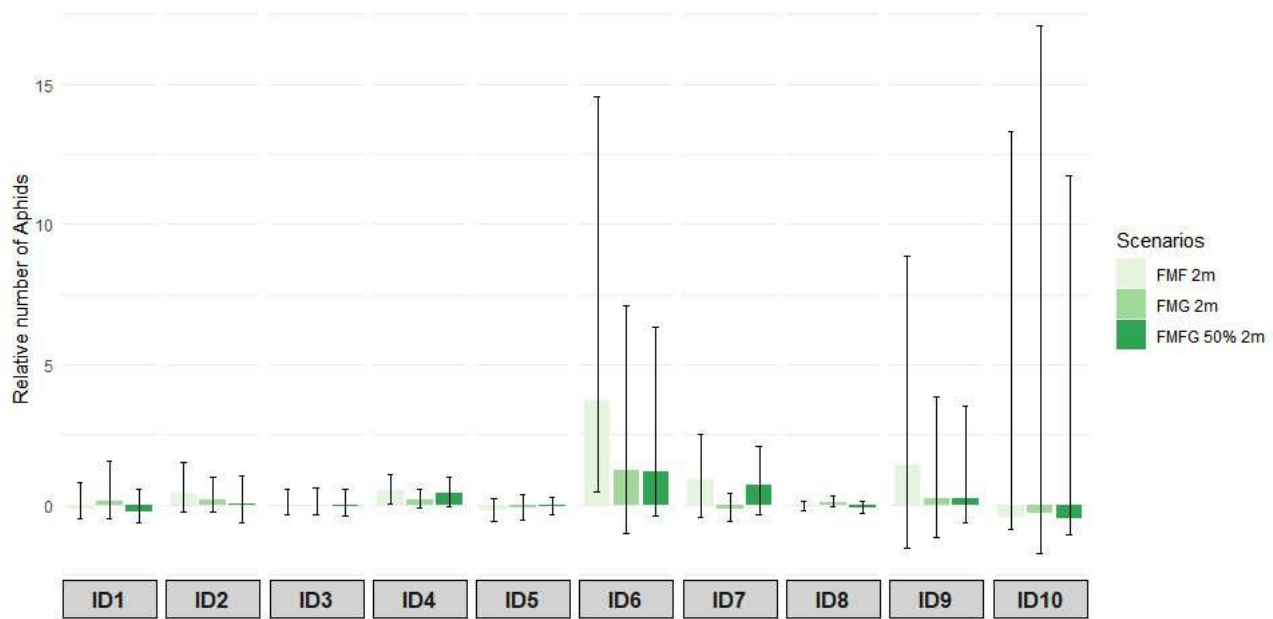


Figure 7.163 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

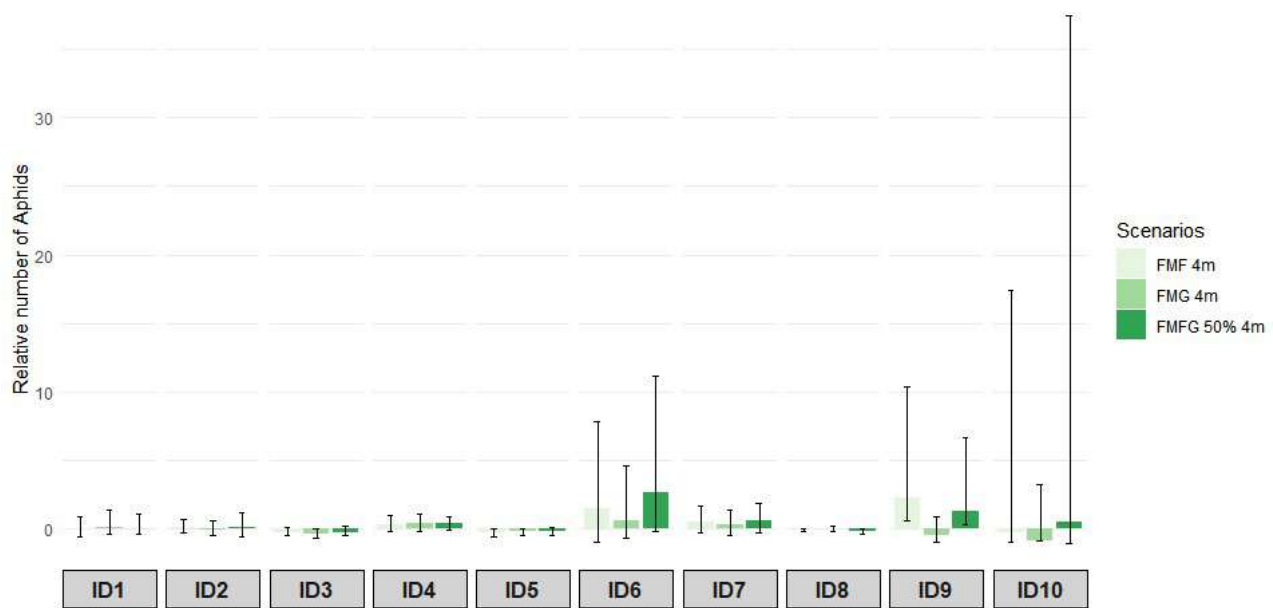


Figure 7.164 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

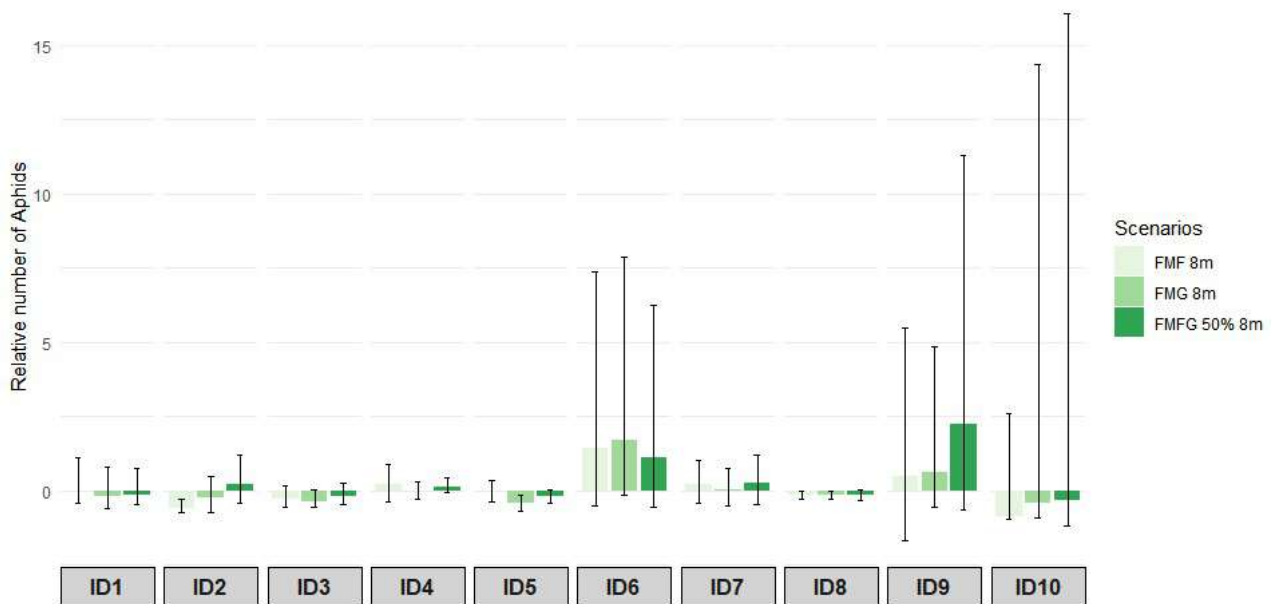


Figure 7.165 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.4.3 In-field relative to landscape

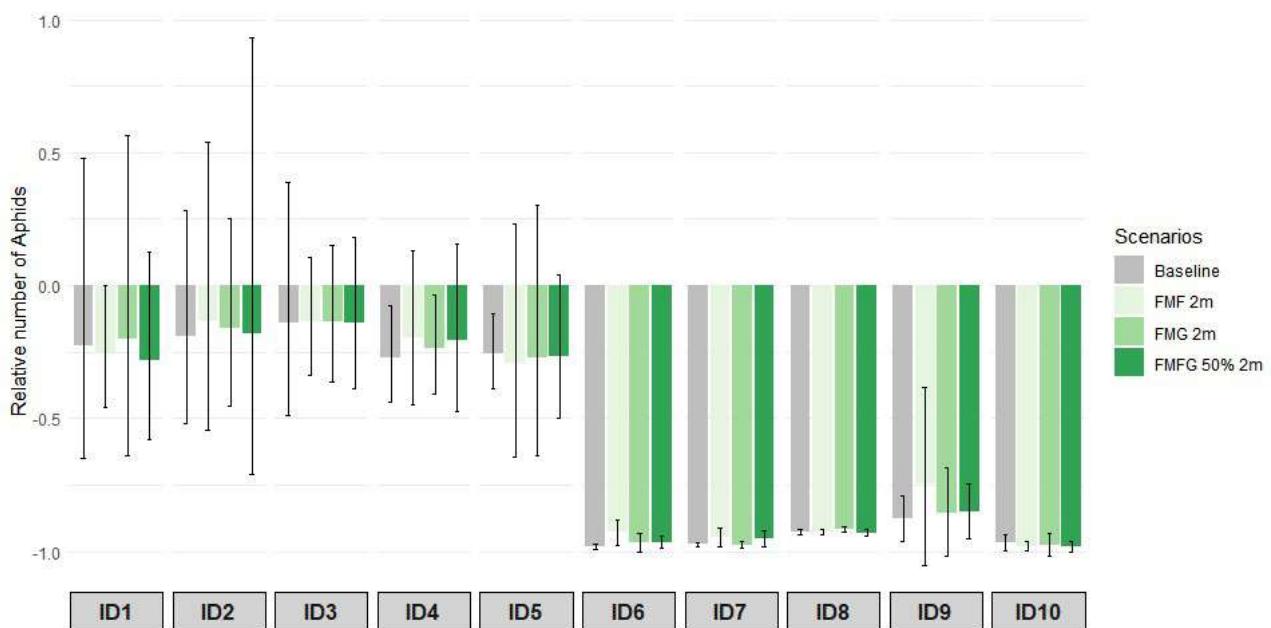


Figure 7.166 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

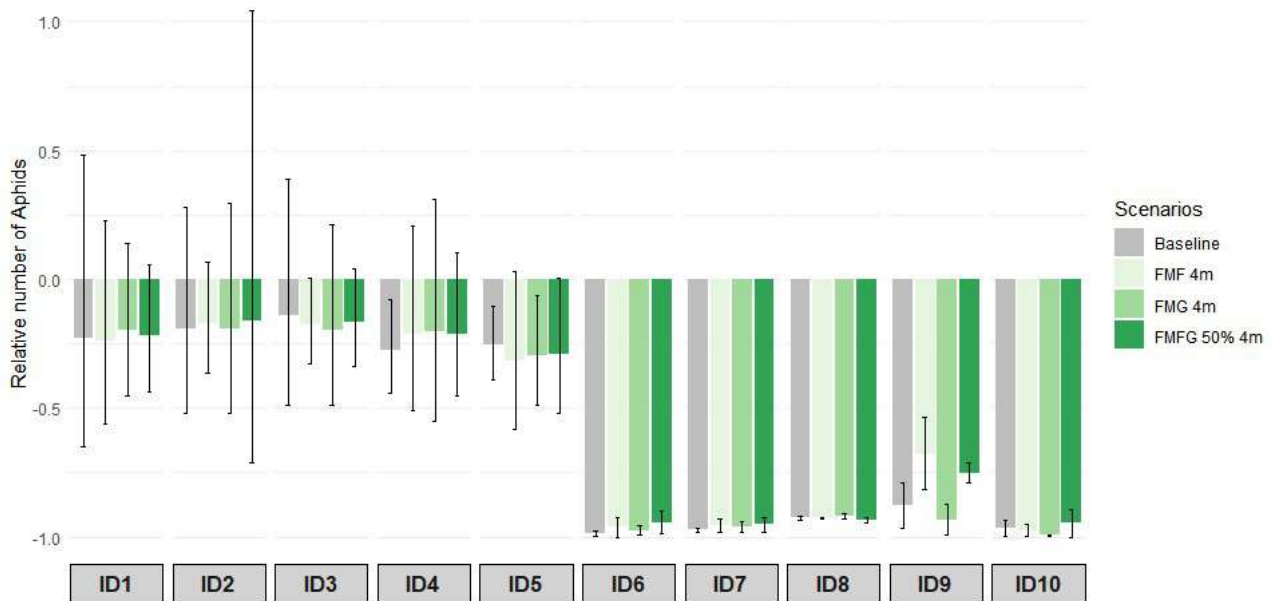


Figure 7.167 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female *Pea* aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

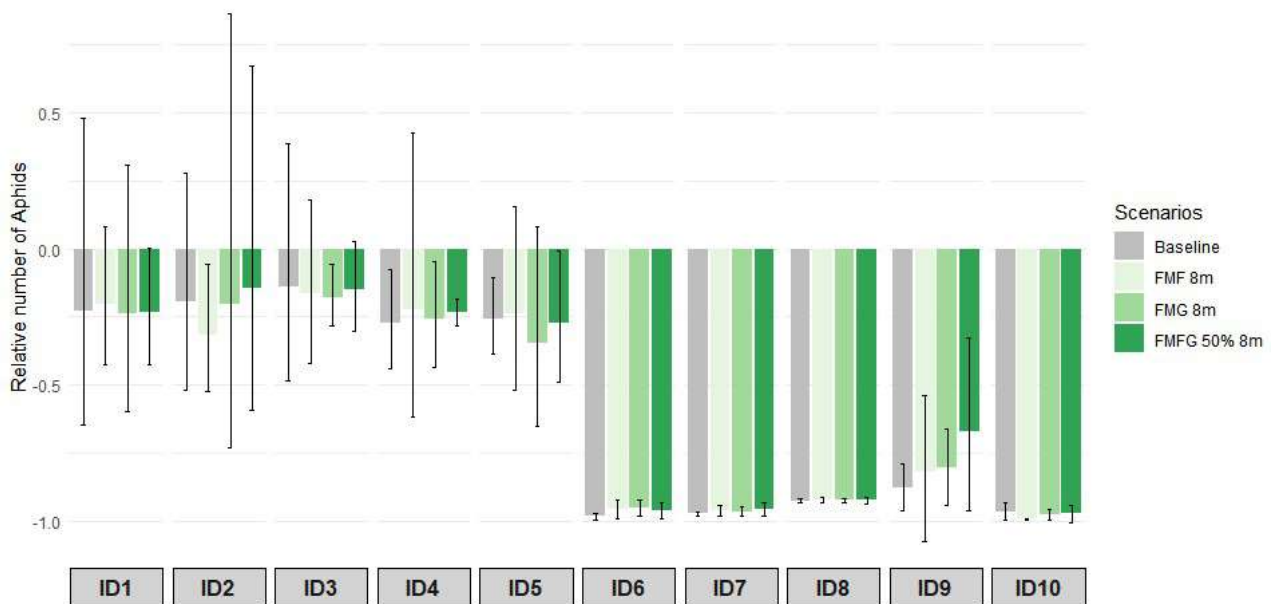


Figure 7.168 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female *Pea* aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.10.5 Setaside

7.10.5.1 Whole landscape

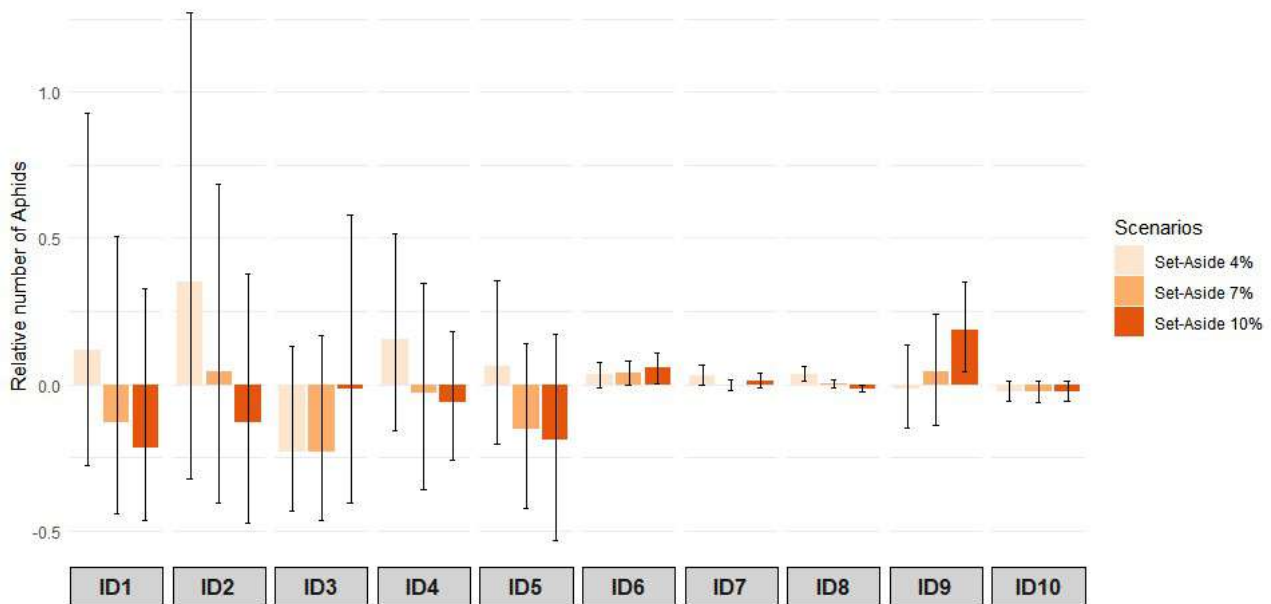


Figure 7.169 Setaside scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.5.2 In-field

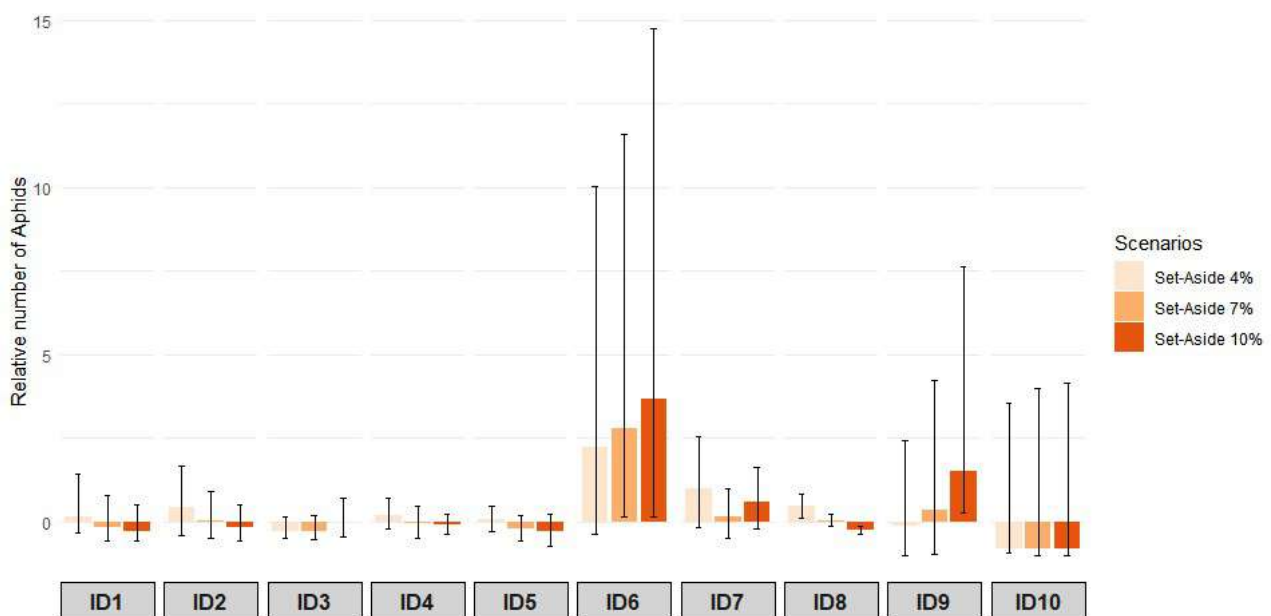


Figure 7.170 Setaside scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.5.3 In-field relative to landscape

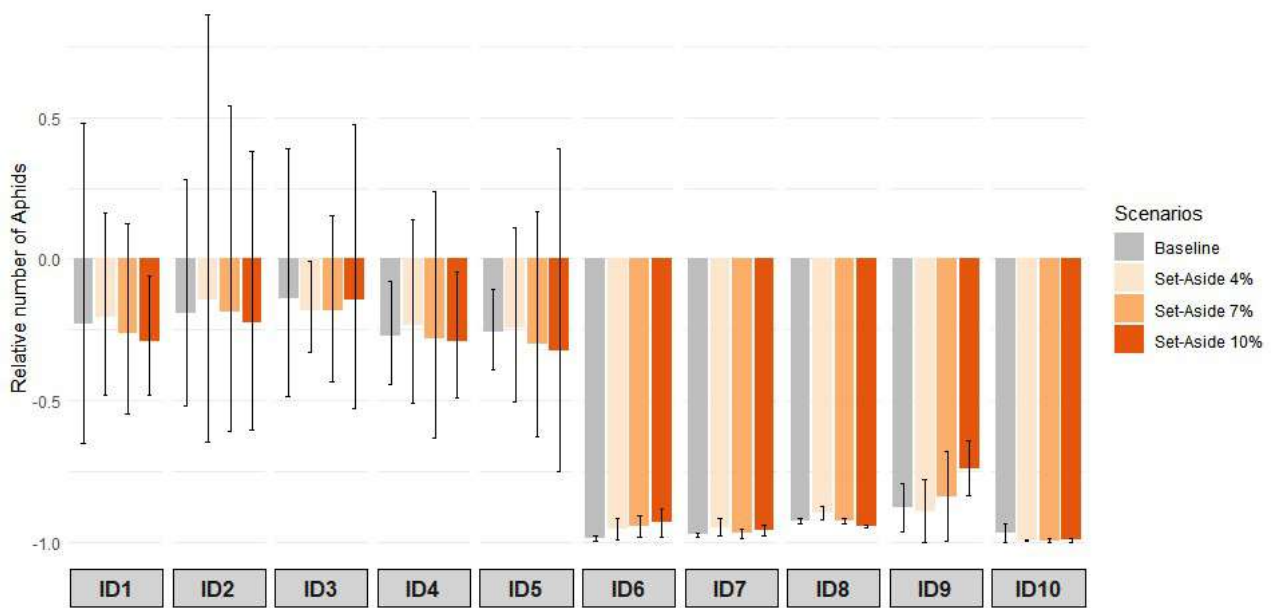


Figure 7.171 Setaside scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.10.6 Legume

7.10.6.1 Whole landscape

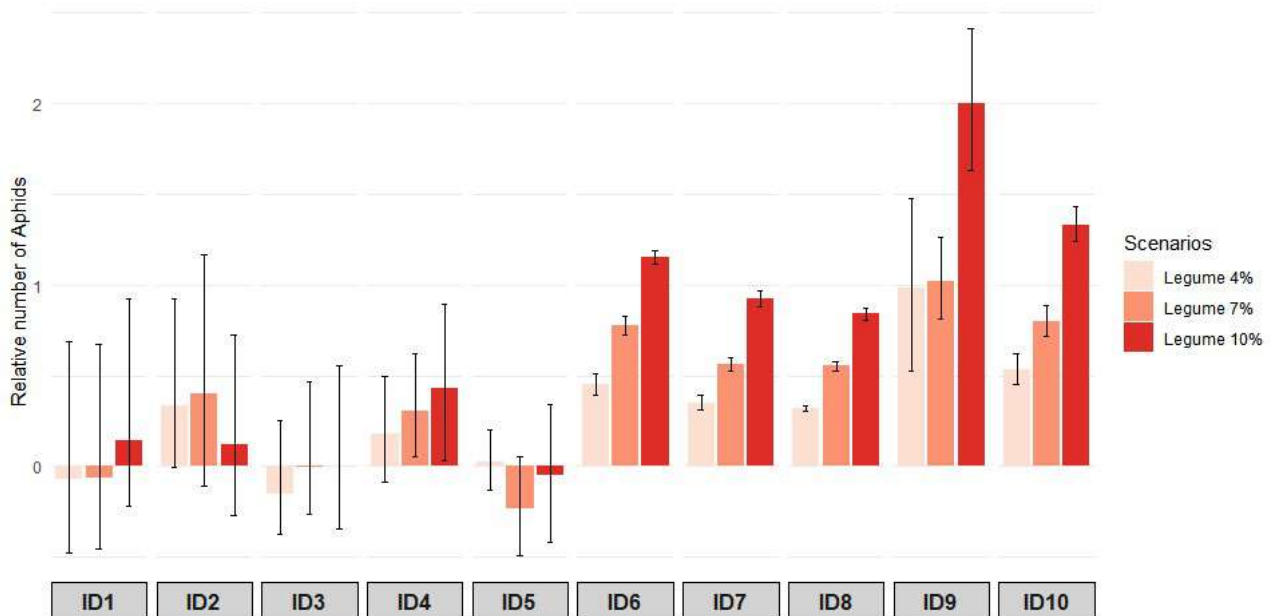


Figure 7.172 Legume scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.6.2 In-field

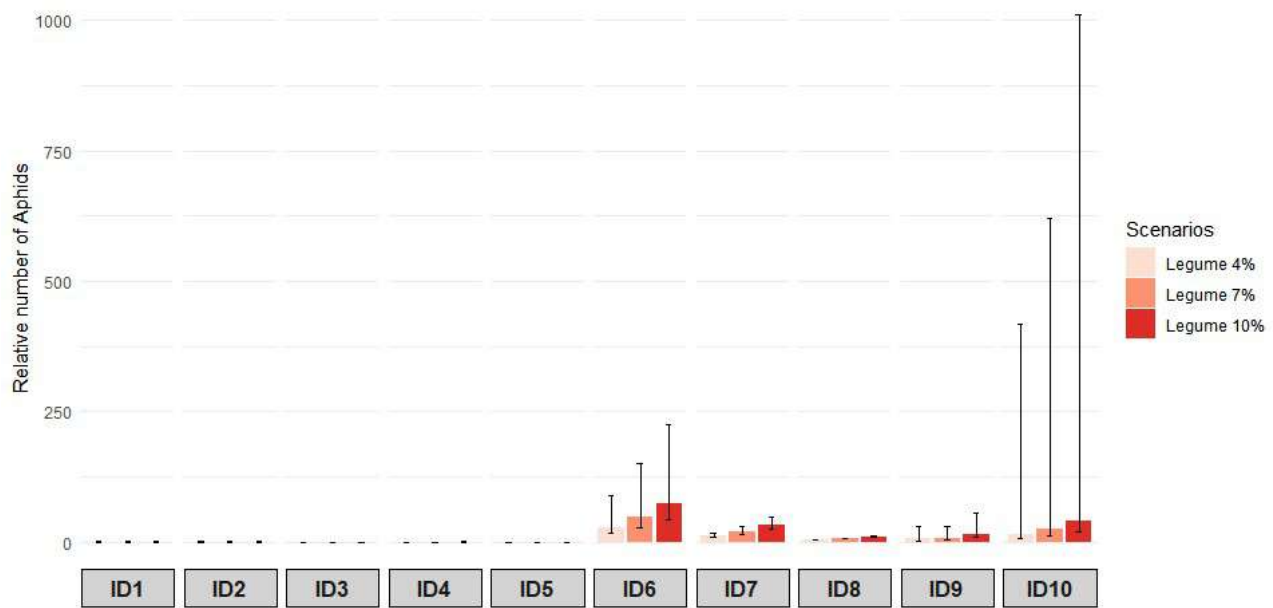


Figure 7.173 Legume scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.6.3 In-field relative to landscape

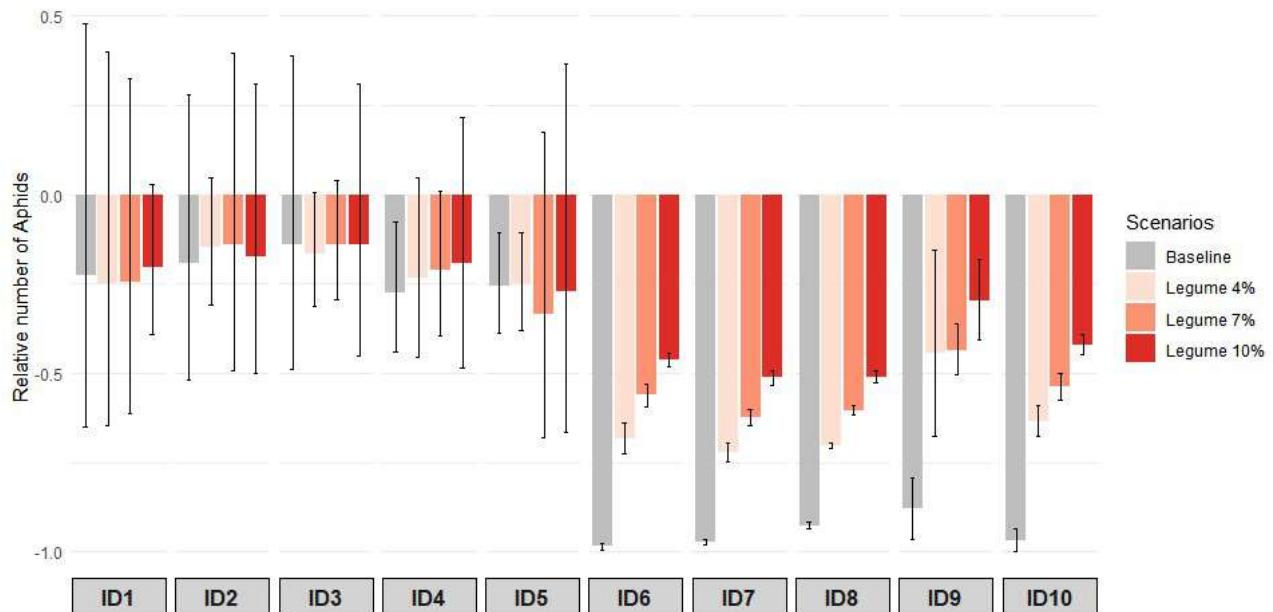


Figure 7.174 Legume scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.10.7 Biopesticides

7.10.7.1 Whole landscape

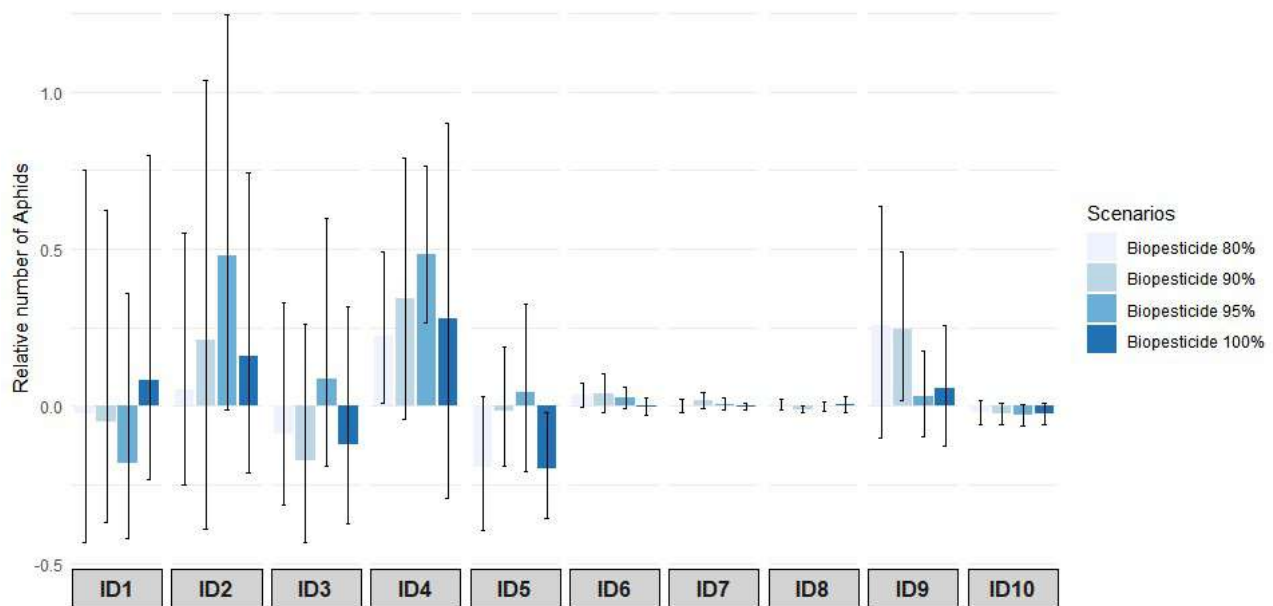


Figure 7.175 Biopesticide scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.10.7.2 In-field

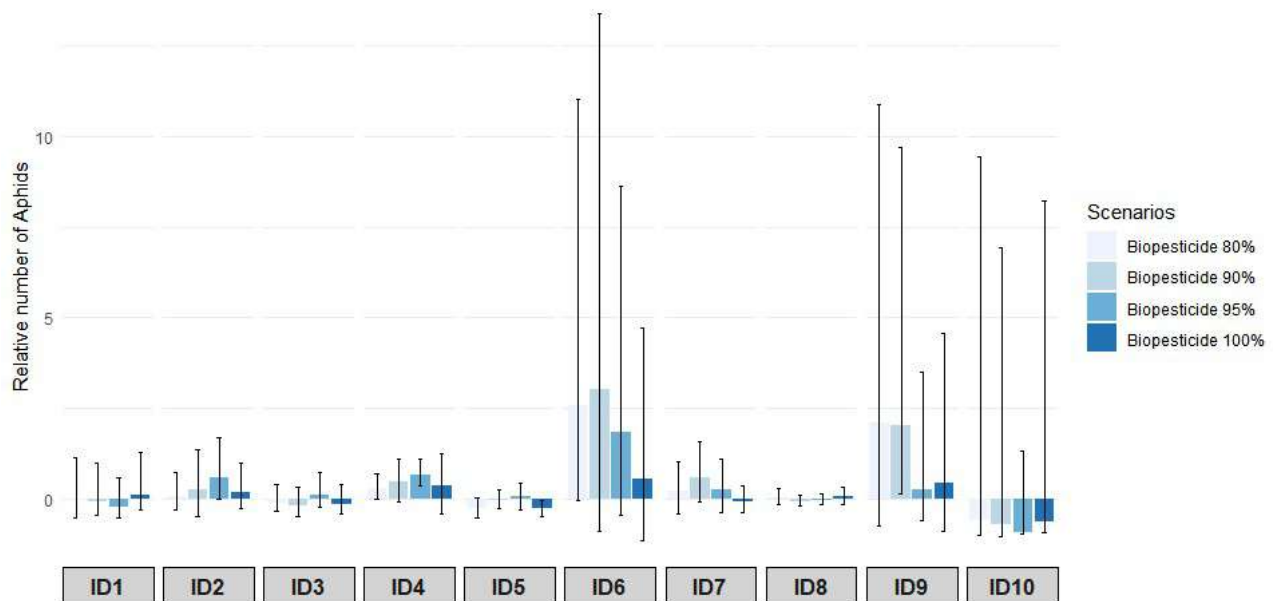


Figure 7.176 Biopesticide scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.10.7.3 In-field relative to landscape

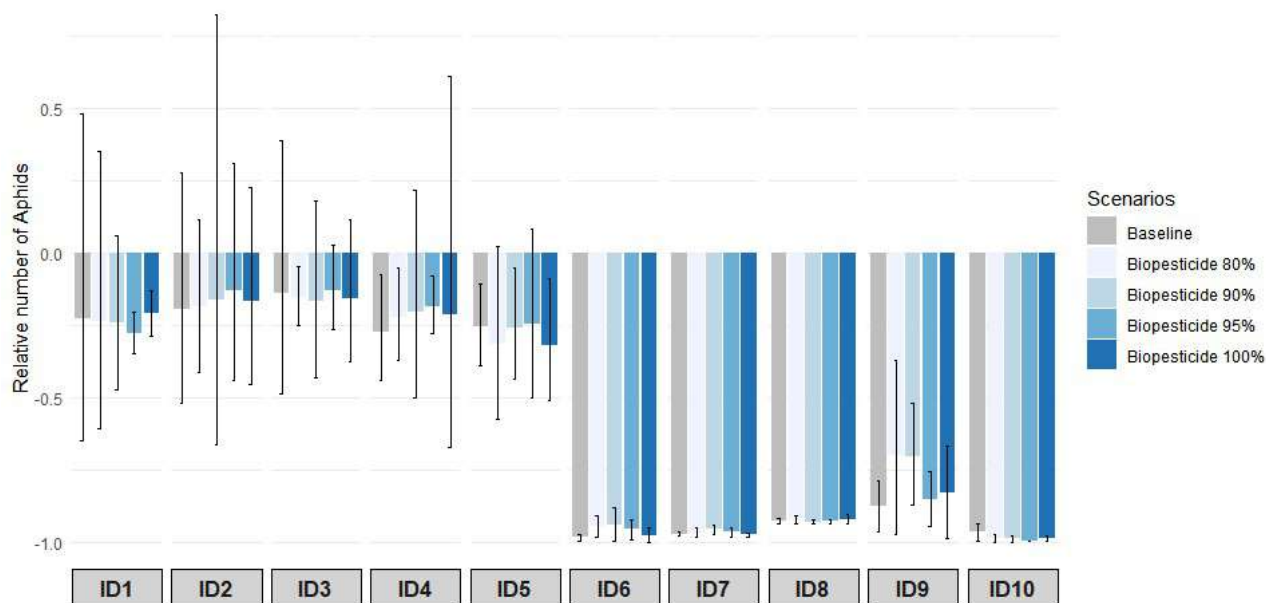


Figure 7.177 Biopesticide scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany. 7.11 Denmark

7.11.1 Crop diversification

7.11.1.1 Whole landscape

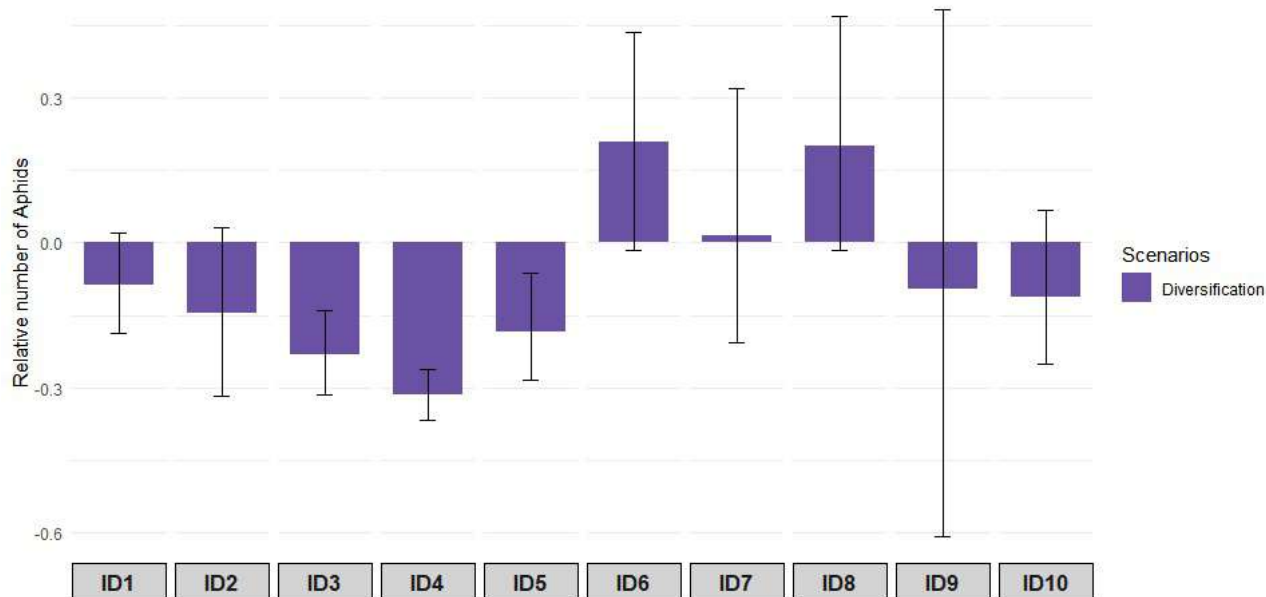


Figure 7.178 Diversification scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.1.2 In-field

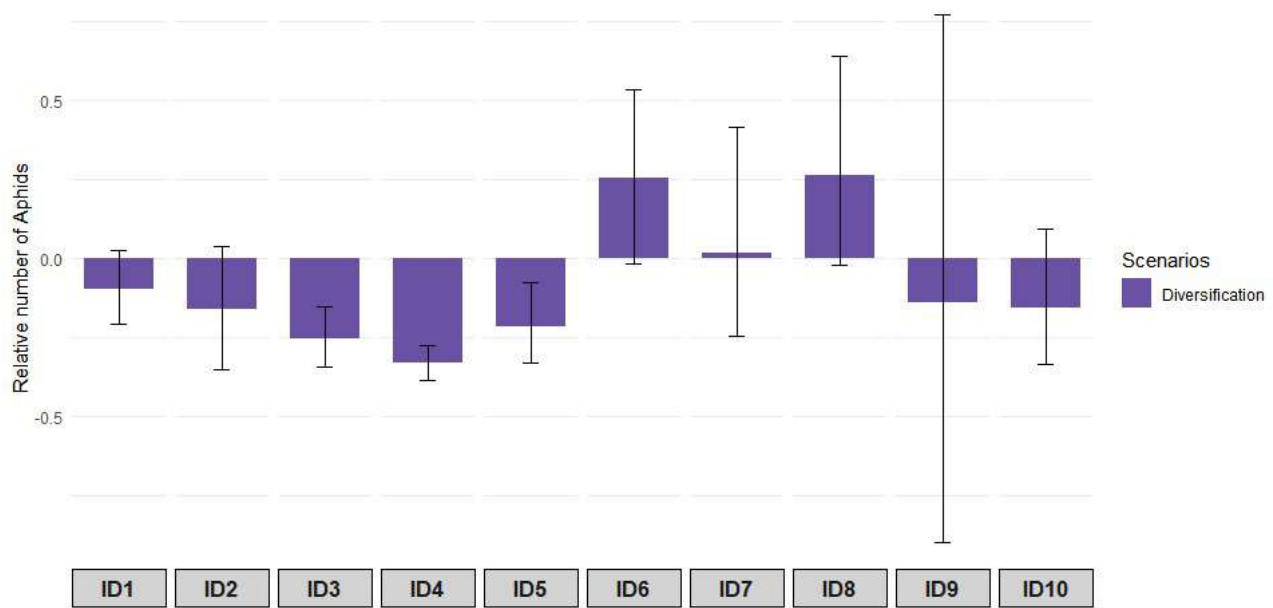


Figure 7.179 Diversification scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.1.3 In-field relative to landscape

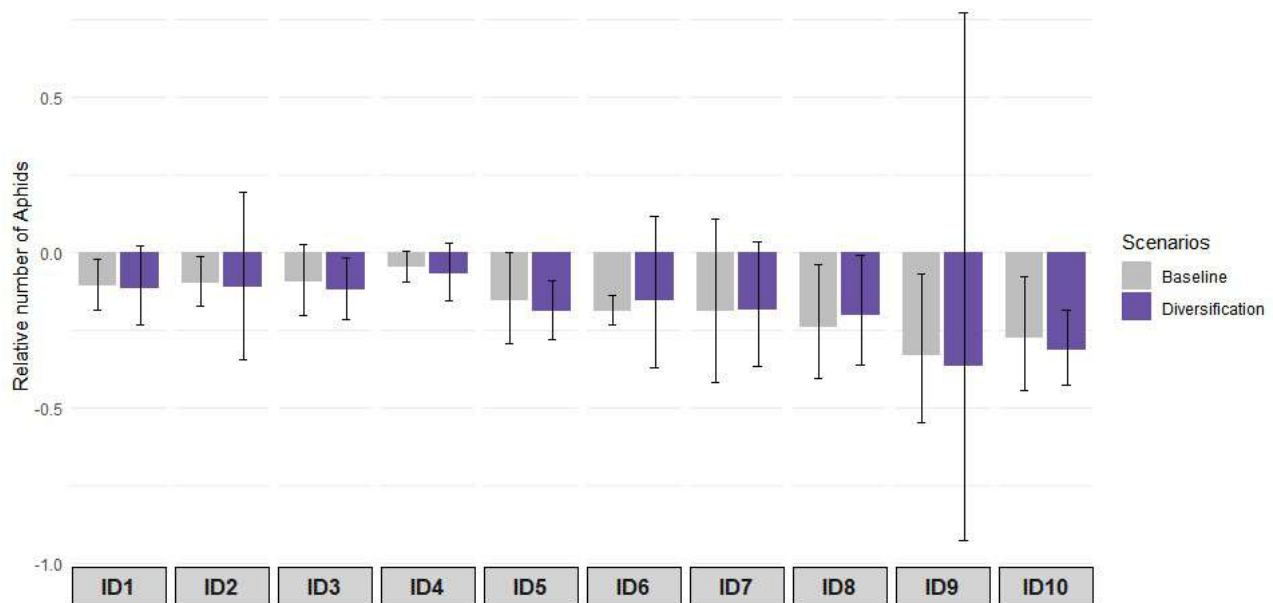


Figure 7.180 Diversification scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.2 Flower field margins

7.11.2.1 Whole landscape

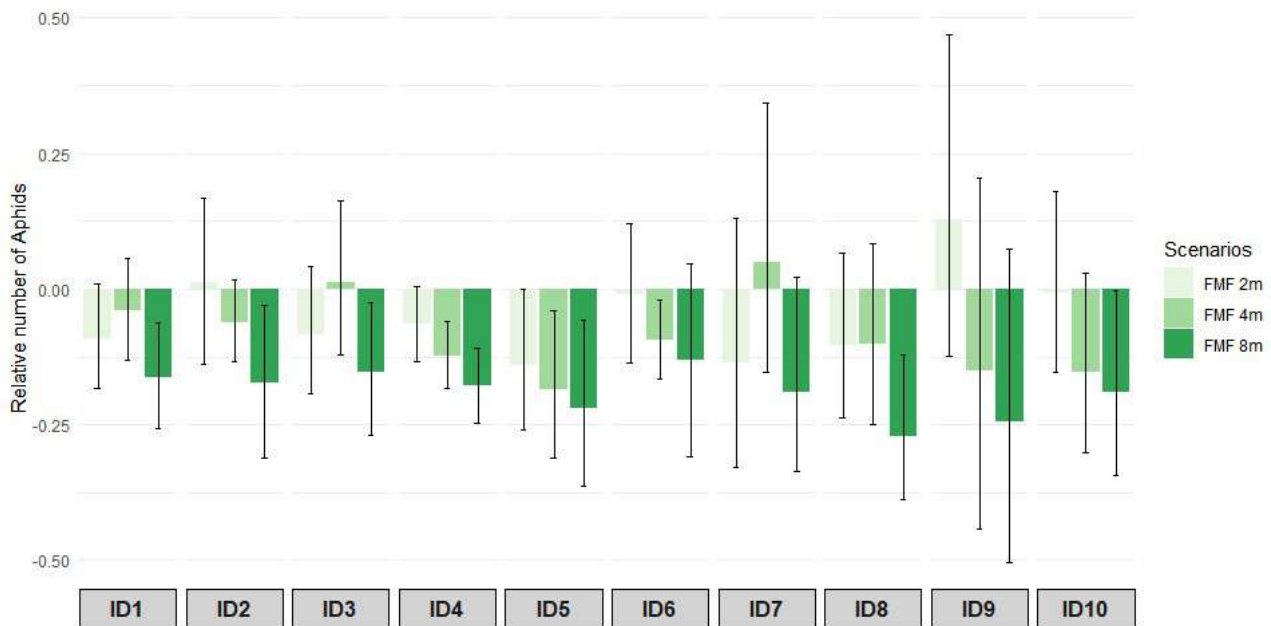


Figure 7.181 Flower field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.2.2 In-field

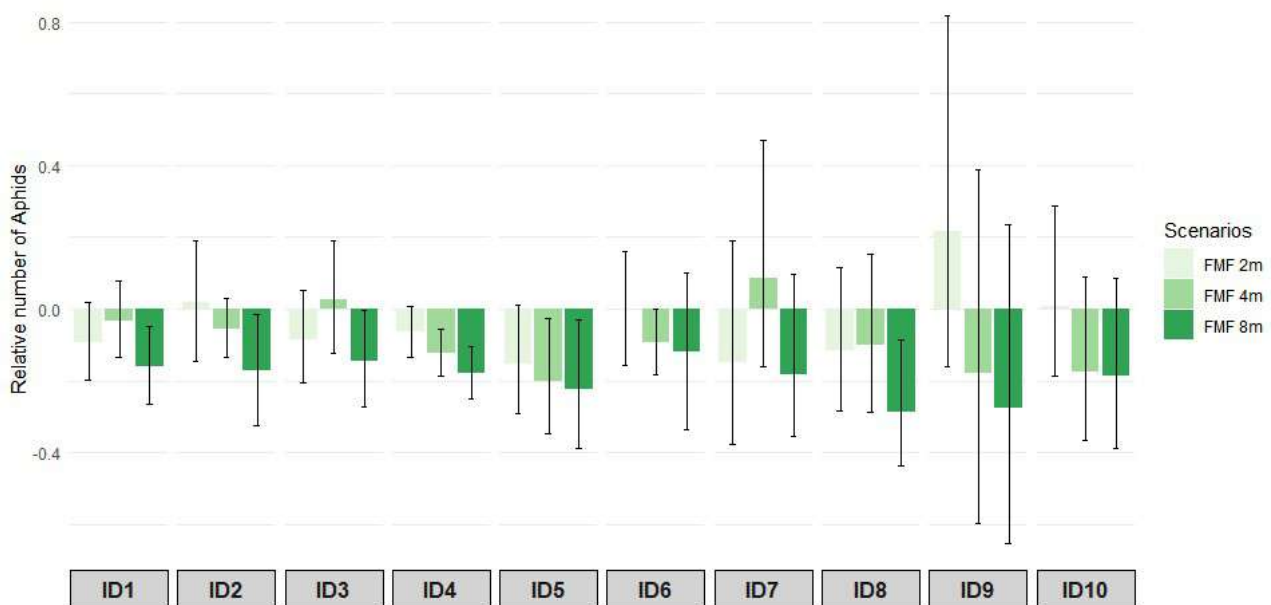


Figure 7.182 Flower field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.2.3 In-field relative to landscape

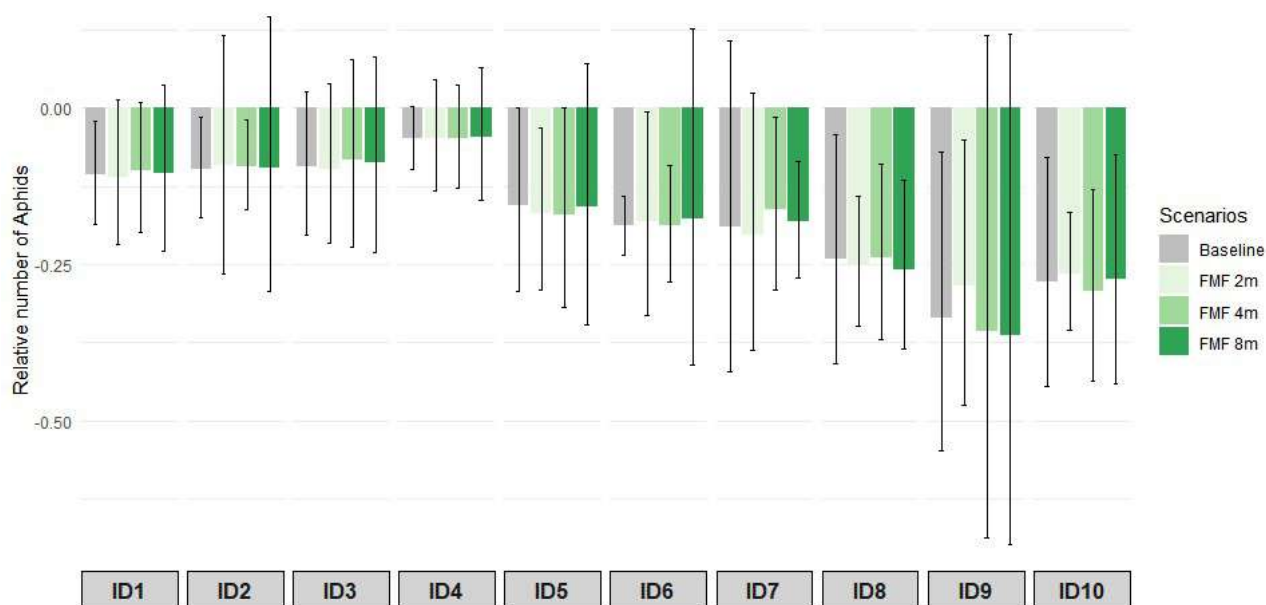


Figure 7.183 Flower field margins scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.3 Grass field margins

7.11.3.1 Whole landscape

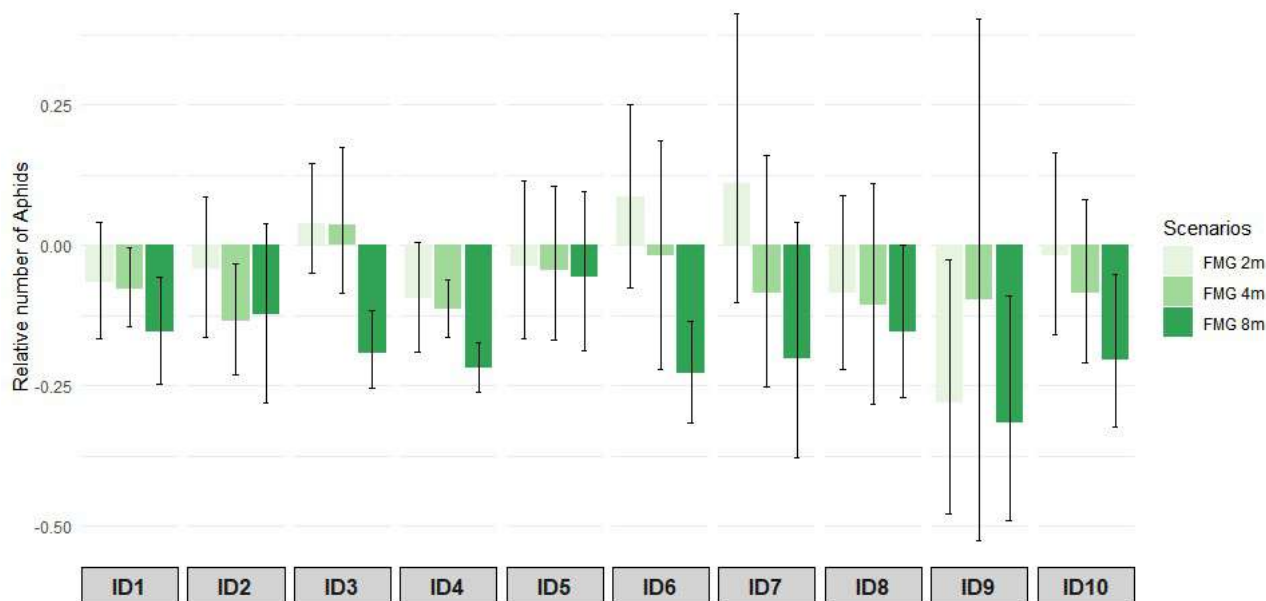


Figure 7.184 Grassy field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.3.2 In-field

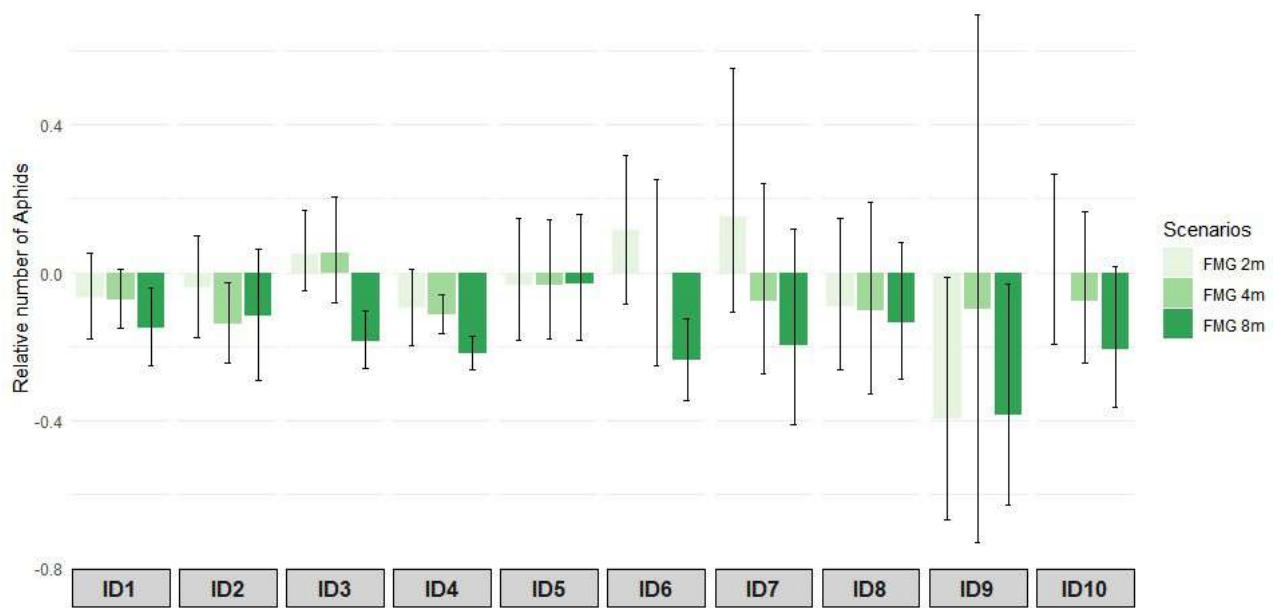


Figure 7.185 Grassy field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.3.3 In-field relative to landscape

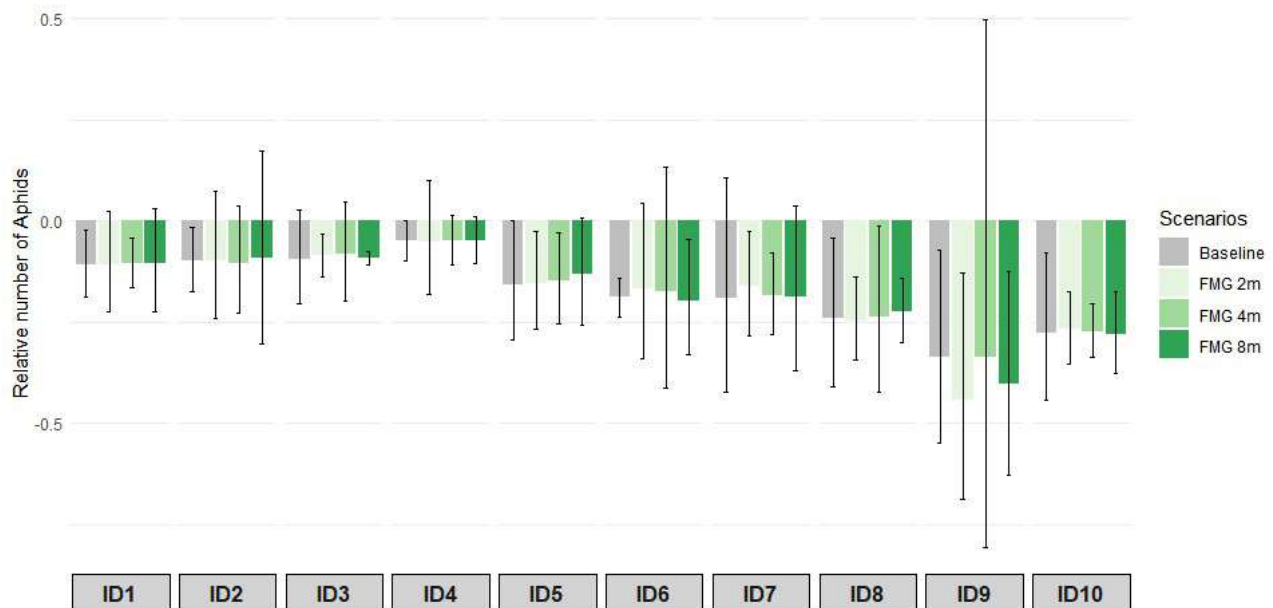


Figure 7.186 Grassy field margins scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.4 Mixed field margins

7.11.4.1 Whole landscape

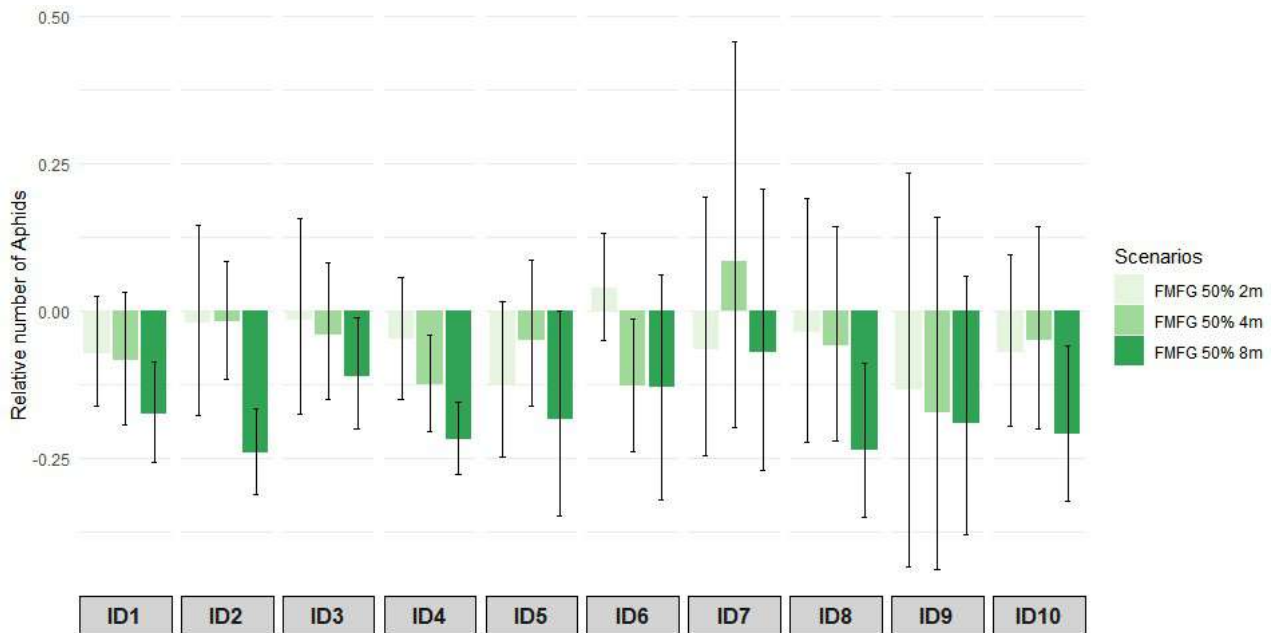


Figure 7.187 Mixed field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.4.2 In-field

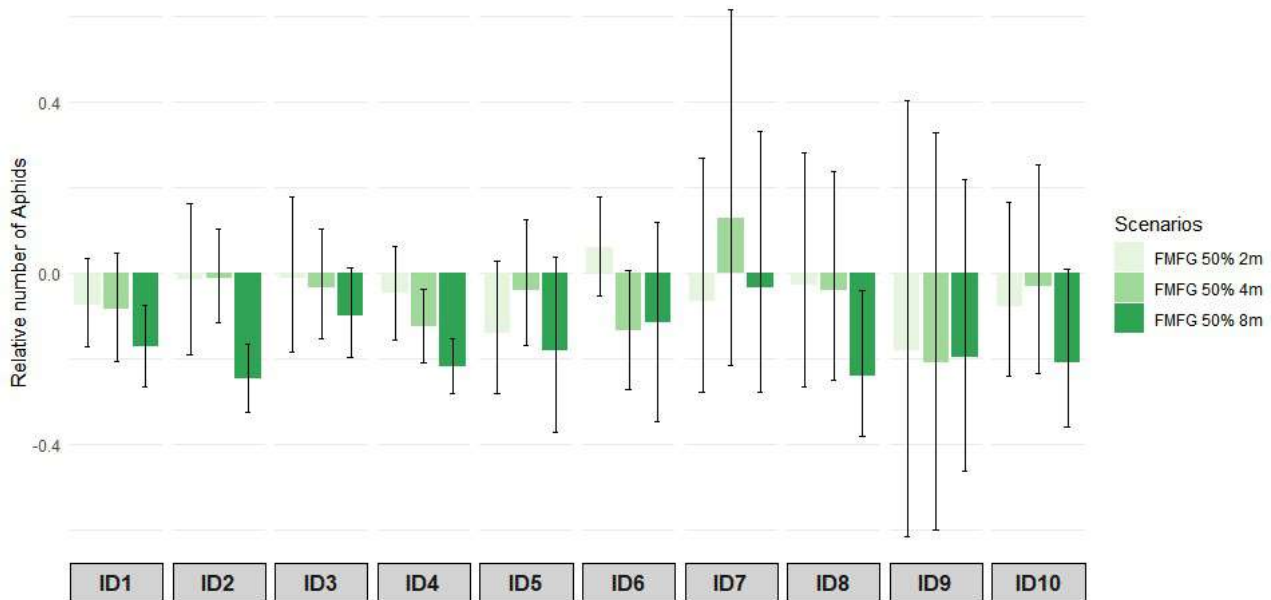


Figure 7.188 Mixed field margins scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.4.3 In-field relative to landscape

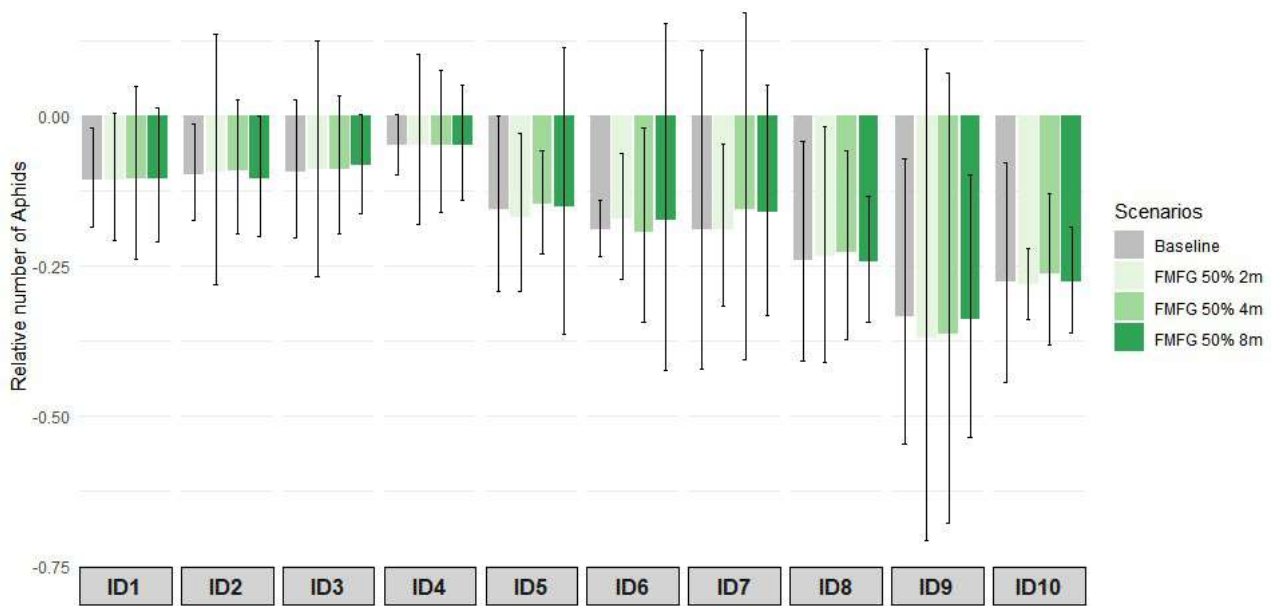


Figure 7.189 Mixed field margins scenario with relative change in the number of female *Pea* aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.5 Flower, grassy and mixed margins

7.11.5.1 Whole landscape

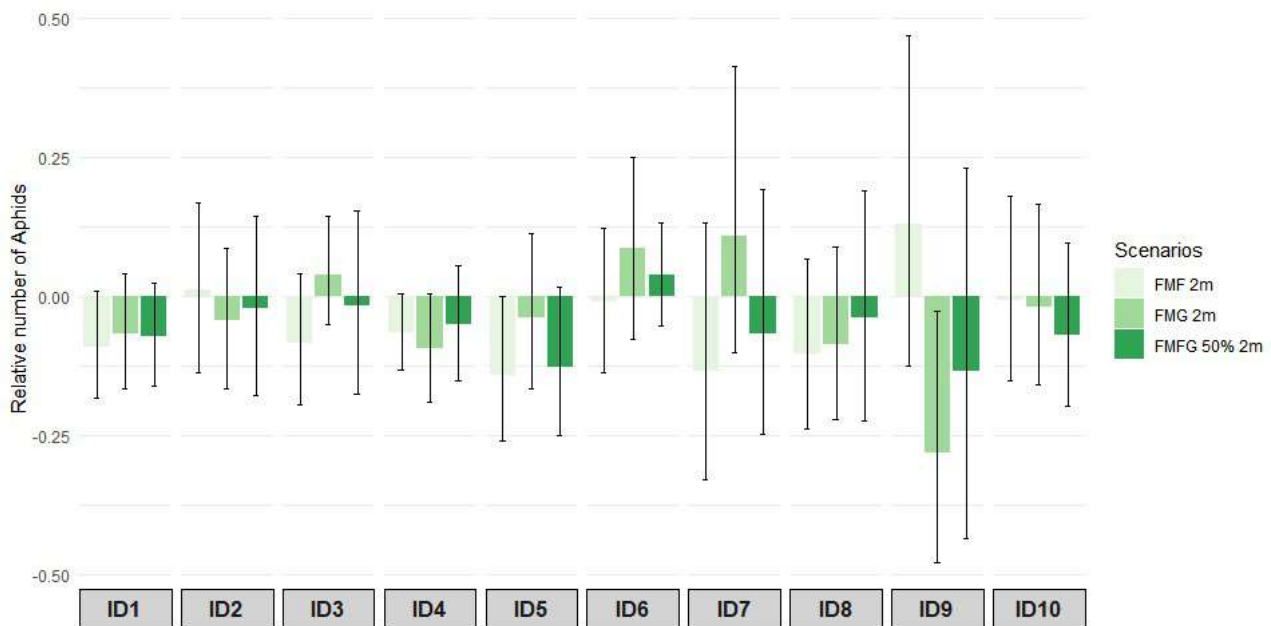


Figure 7.190 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Pea* aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

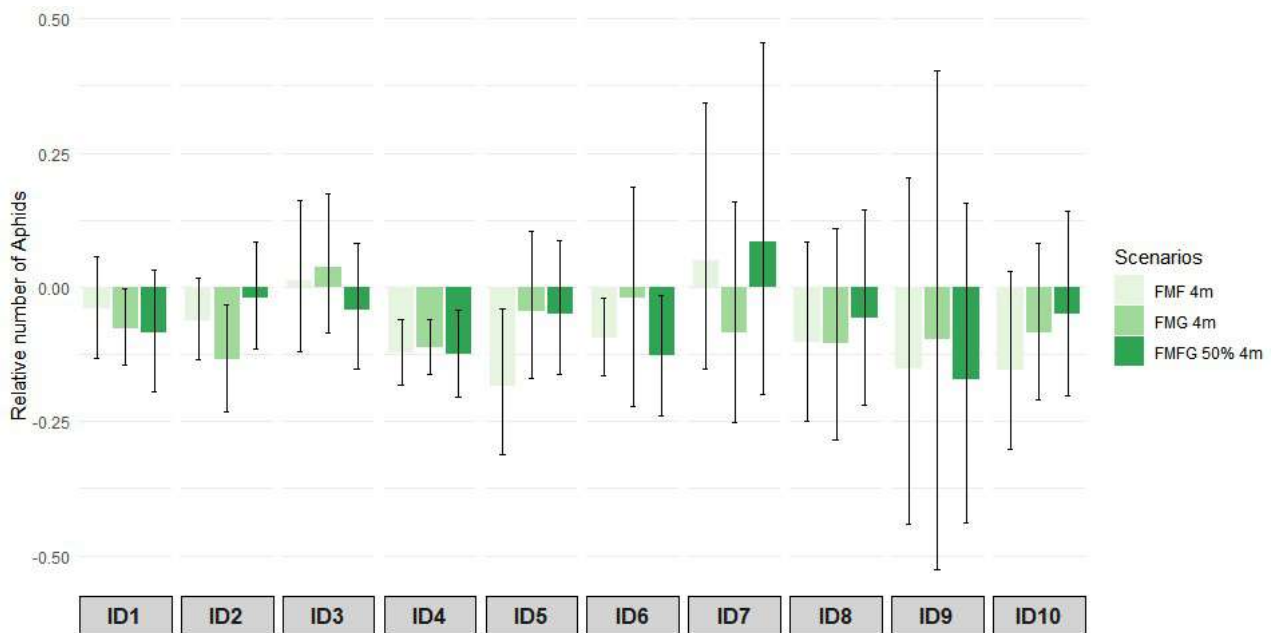


Figure 7.191 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

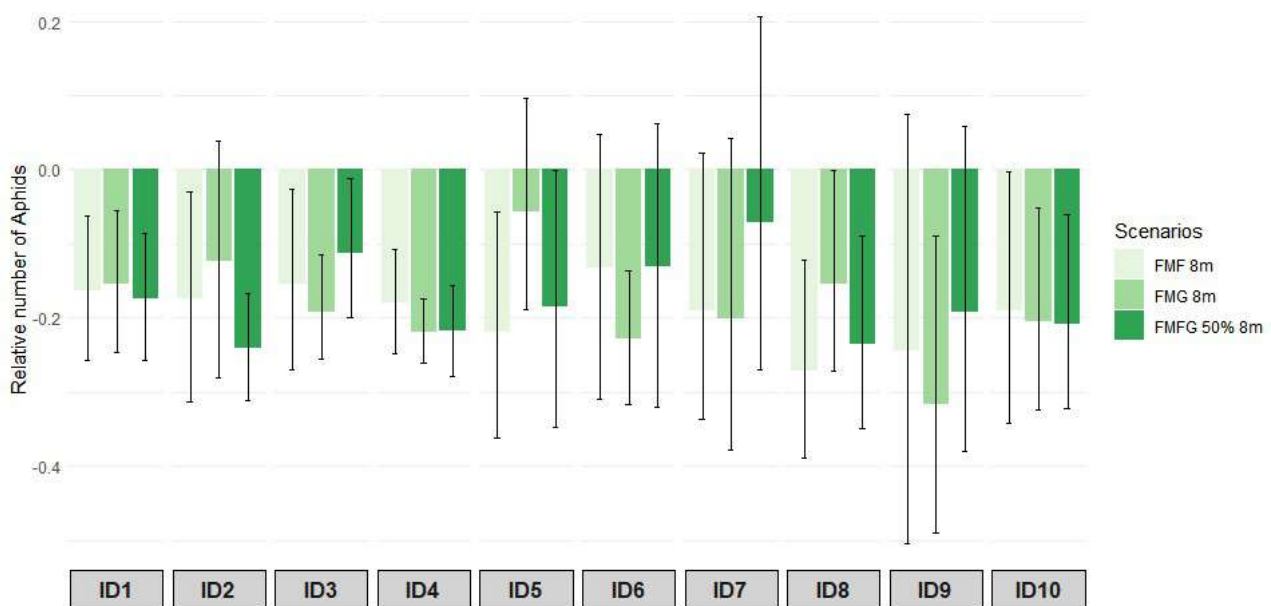


Figure 7.192 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.5.2 In-field

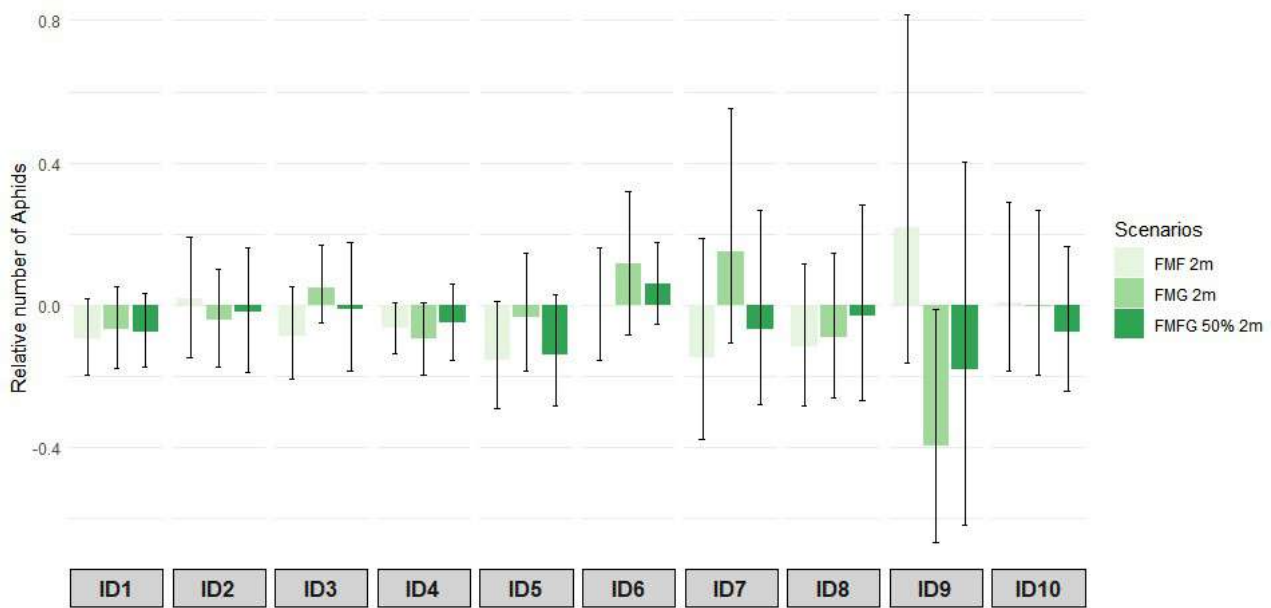


Figure 7.193 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

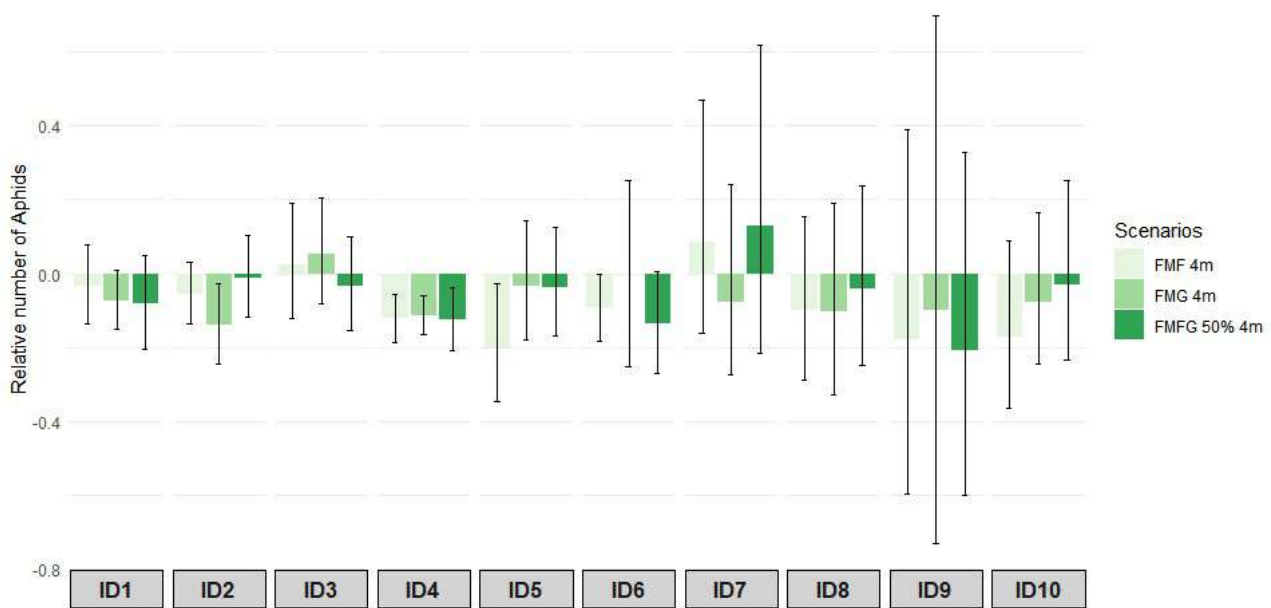


Figure 7.194 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

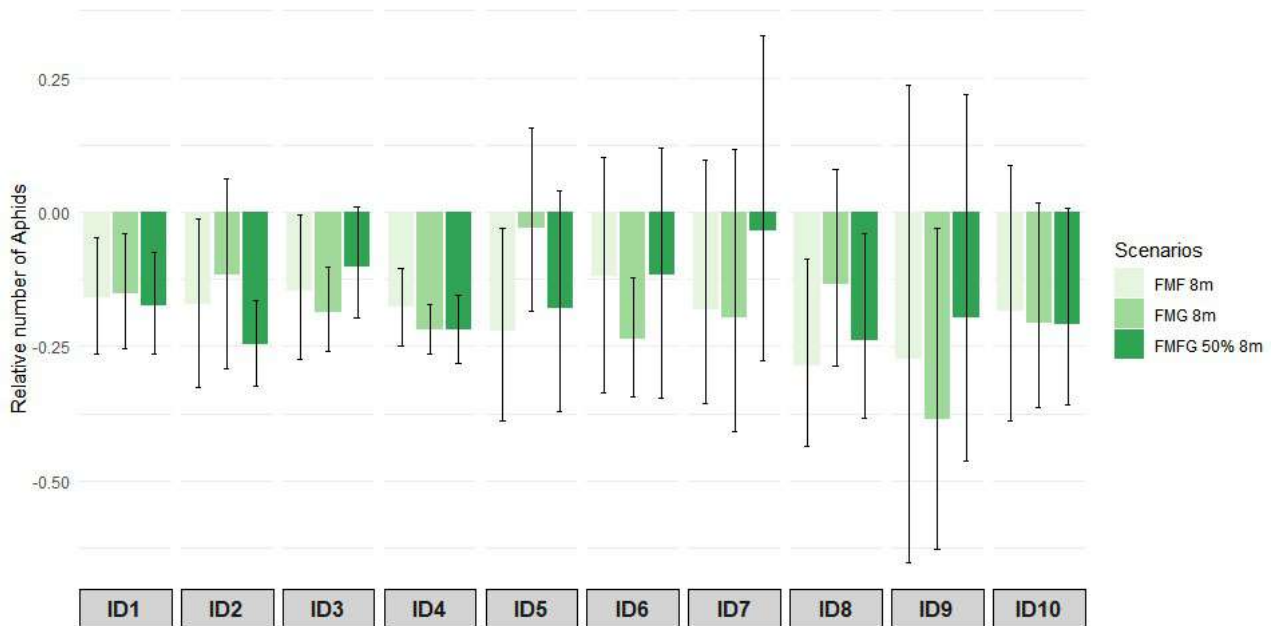


Figure 7.195 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.5.3 In-field relative to landscape

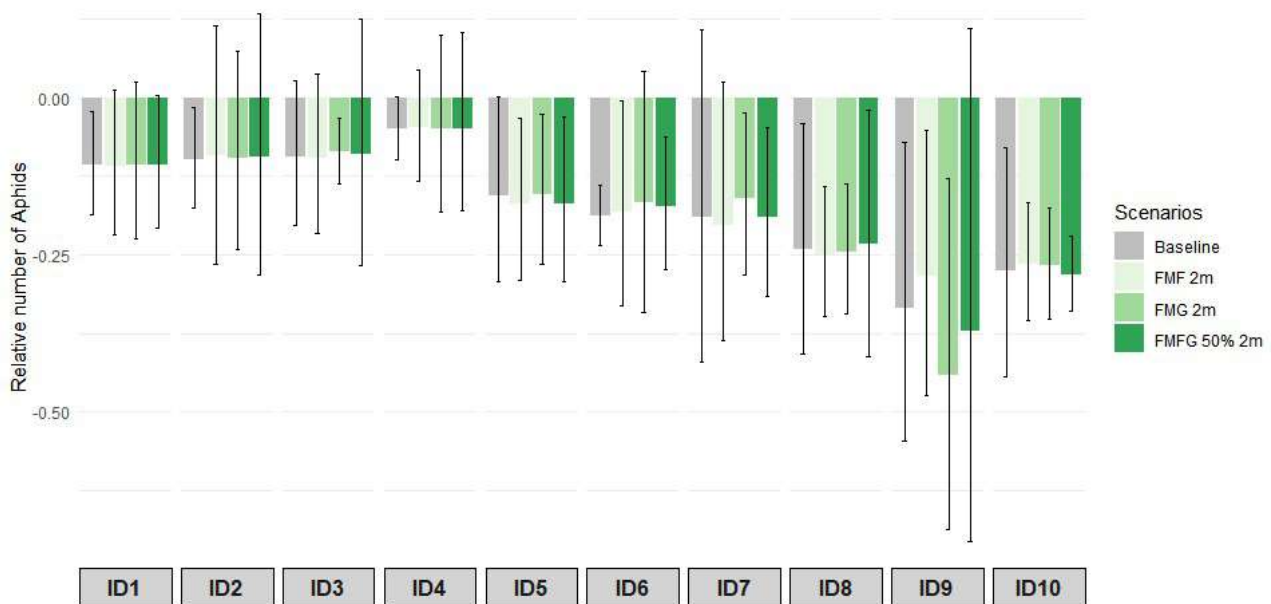


Figure 7.196 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

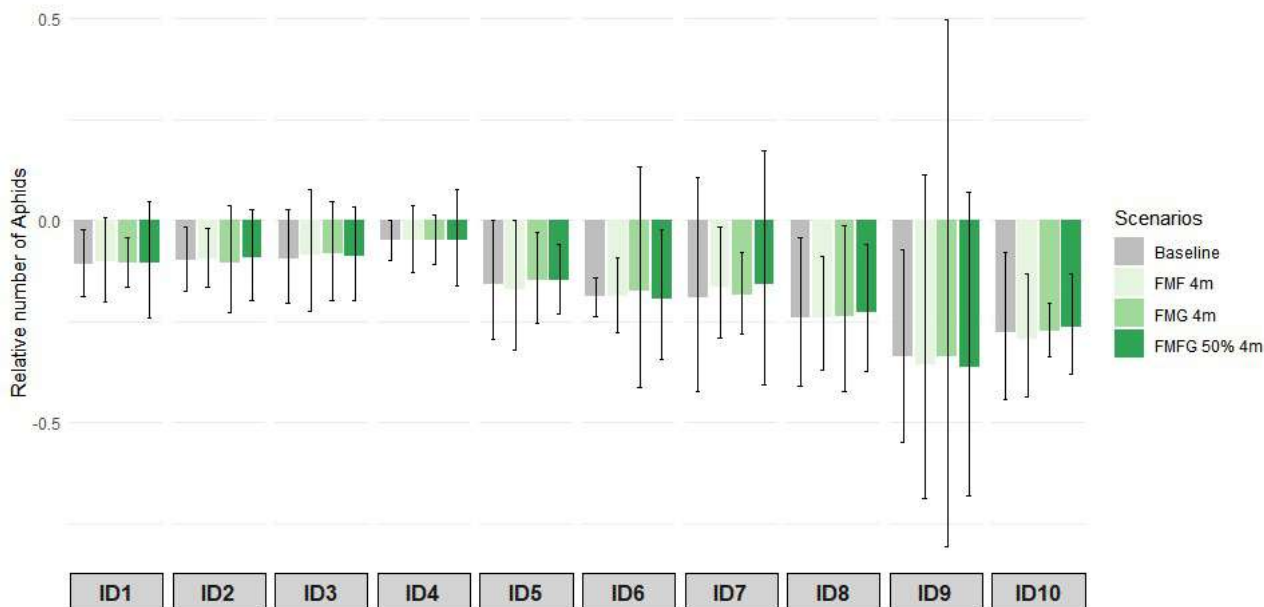


Figure 7.197 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

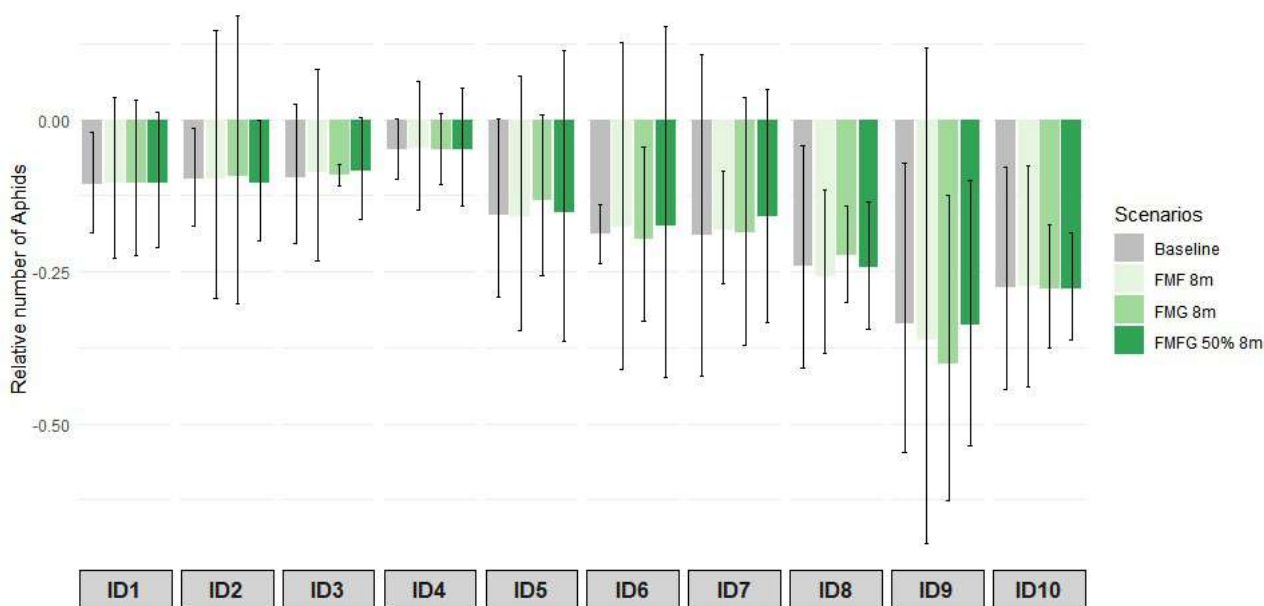


Figure 7.198 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.6 Setaside

7.11.6.1 Whole landscape

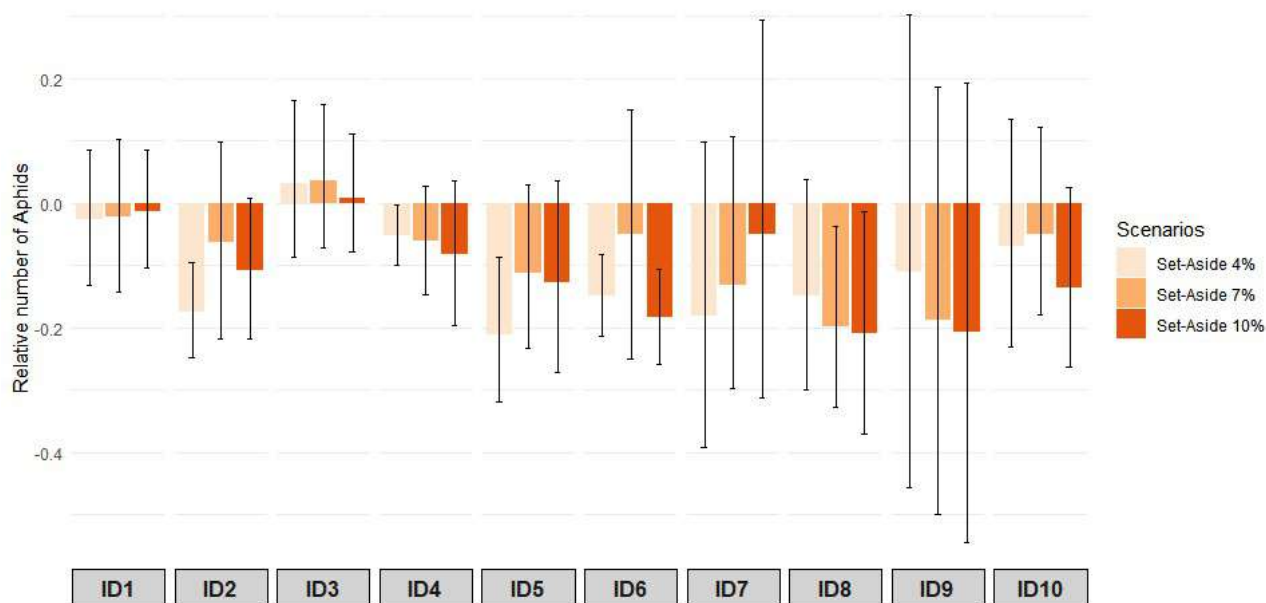


Figure 7.199 Setaside scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark. 7.11.6.2 In-field

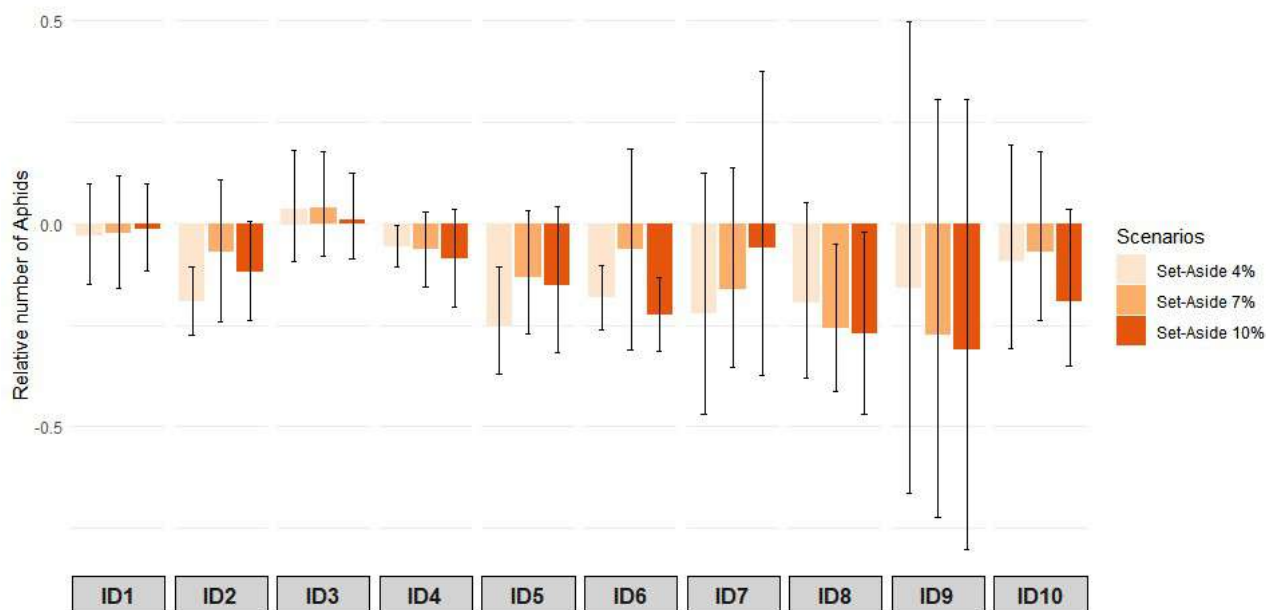


Figure 7.200 Setaside scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.6.3 In-field relative to landscape

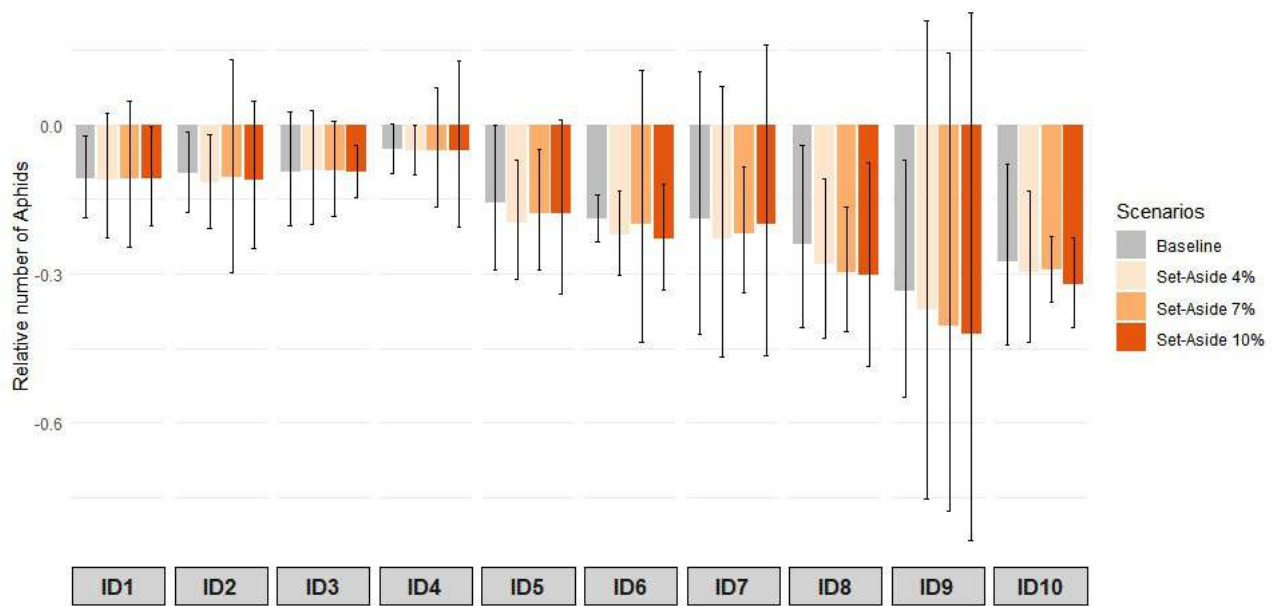


Figure 7.201 Setaside scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.7 Legume

7.11.7.1 Whole landscape

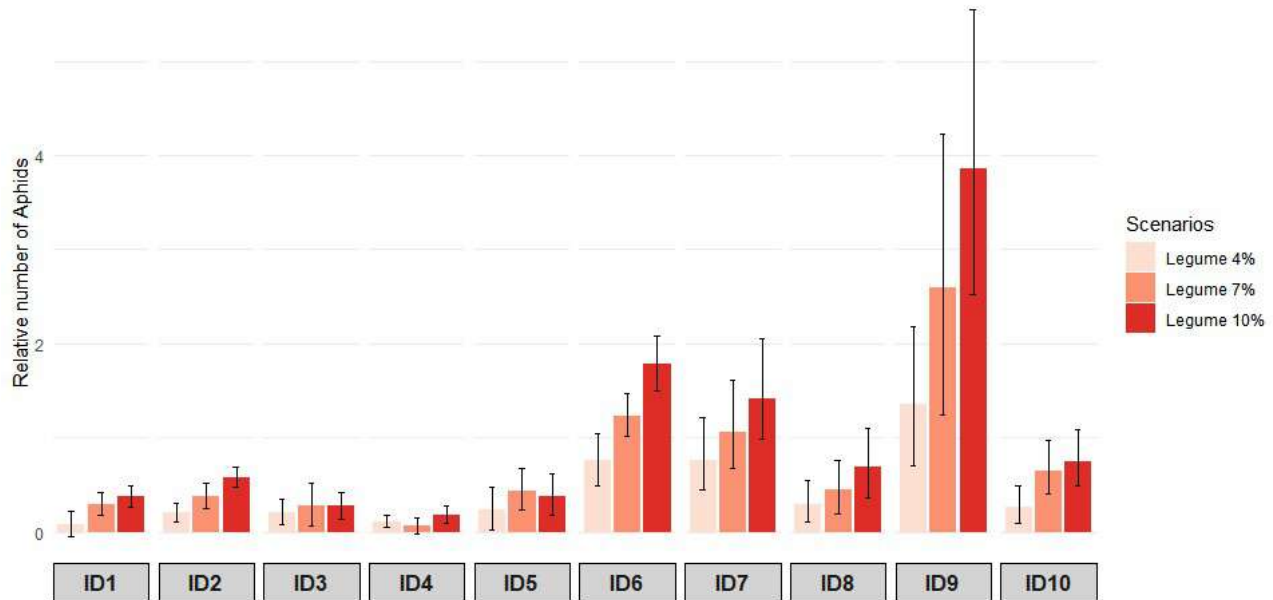


Figure 7.202 Legume scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.7.2 In-field

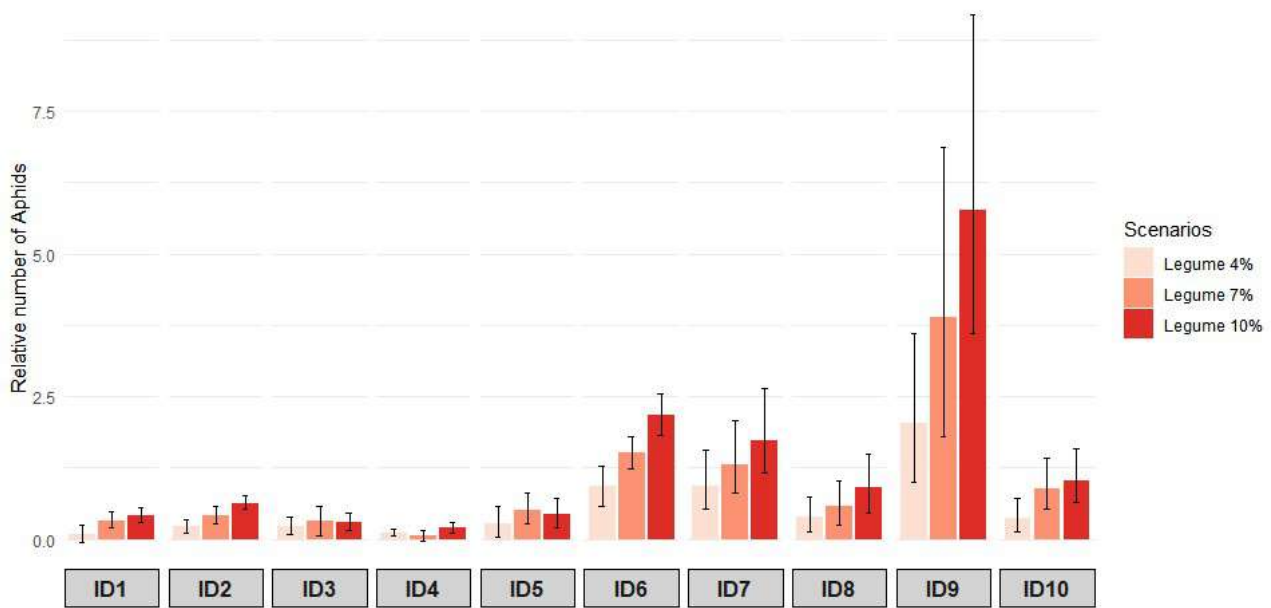


Figure 7.203 Legume scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.7.3 In-field relative to landscape

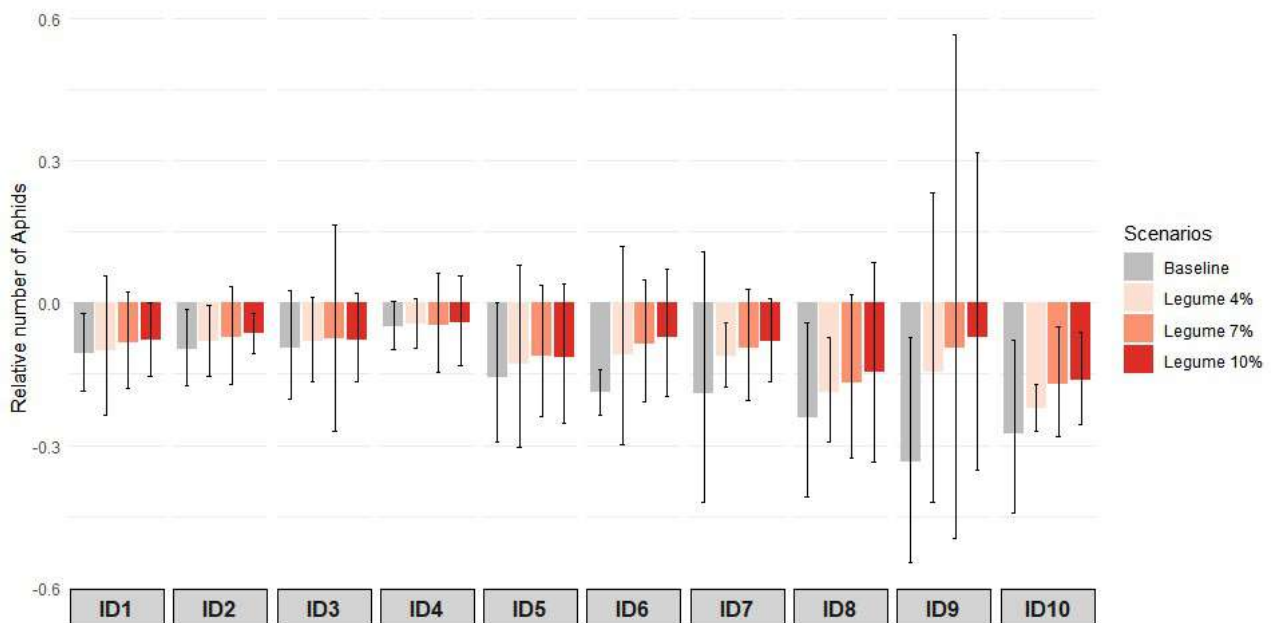


Figure 7.204 Legume scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.11.8 Biopesticides

7.11.8.1 Whole landscape

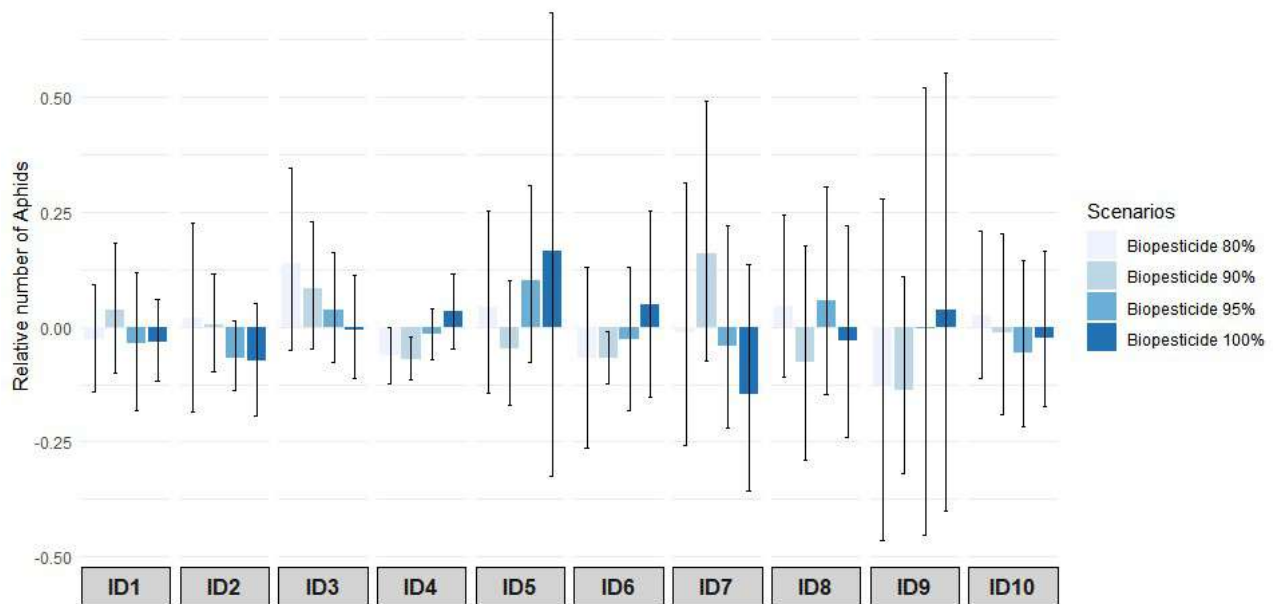


Figure 7.205 Biopesticide scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.11.8.2 In-field

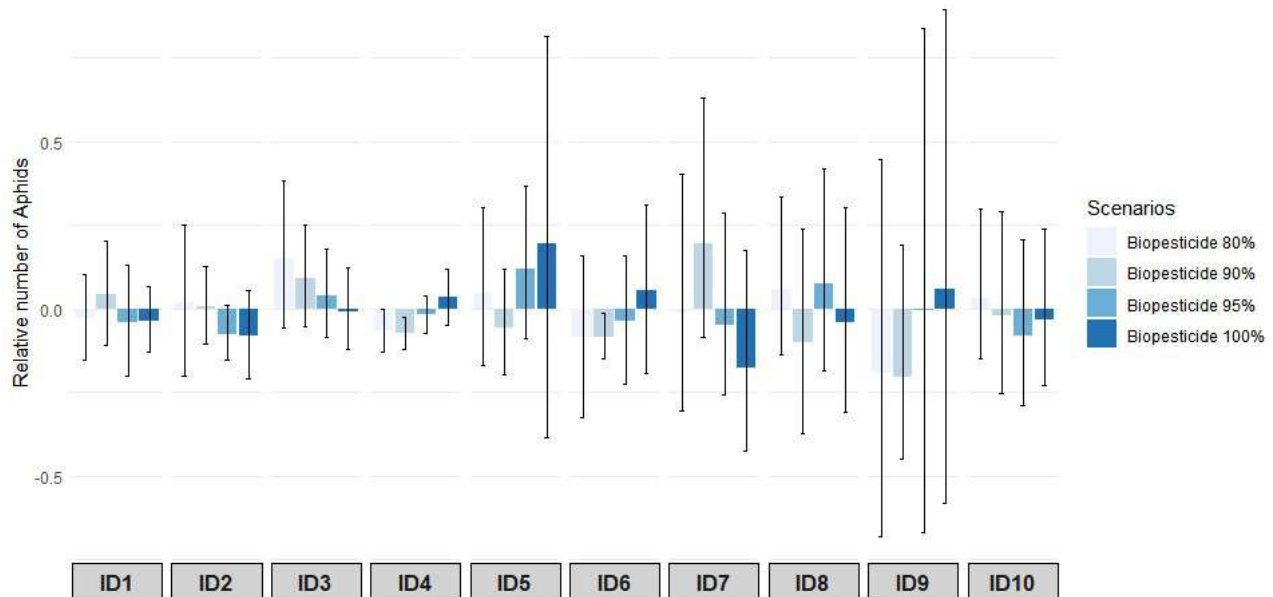


Figure 7.206 Biopesticide scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.11.8.3 In-field relative to landscape

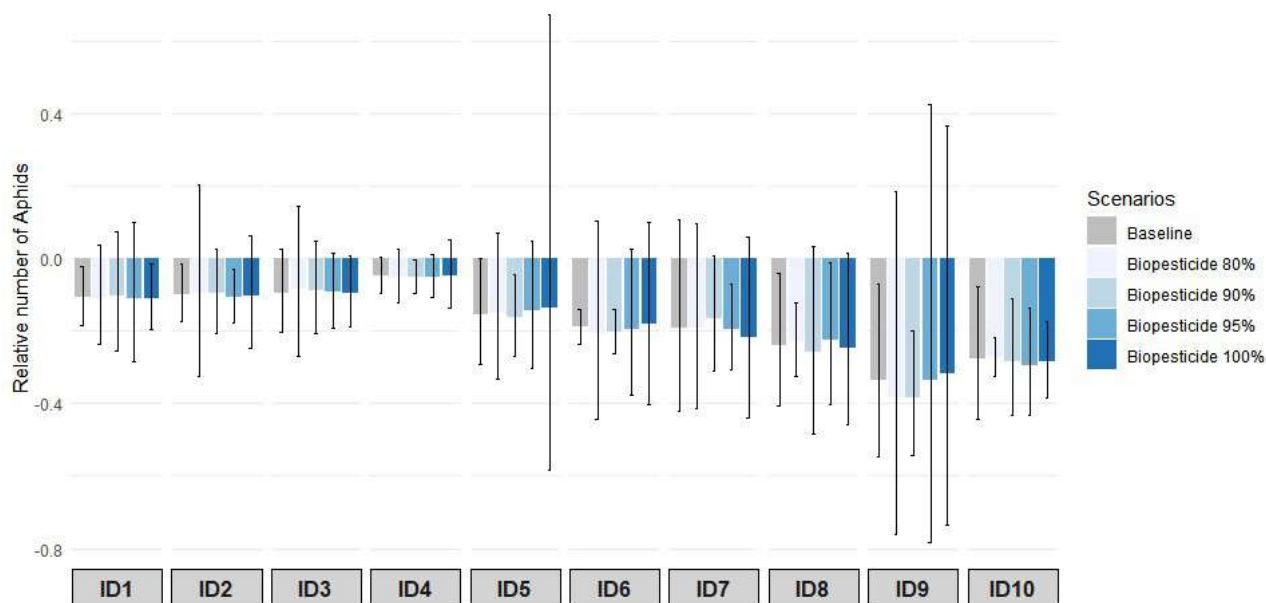


Figure 7.207 Biopesticide scenario with relative change in the number of female Pea aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.12 Combined landscapes

7.12.1 Crop diversification

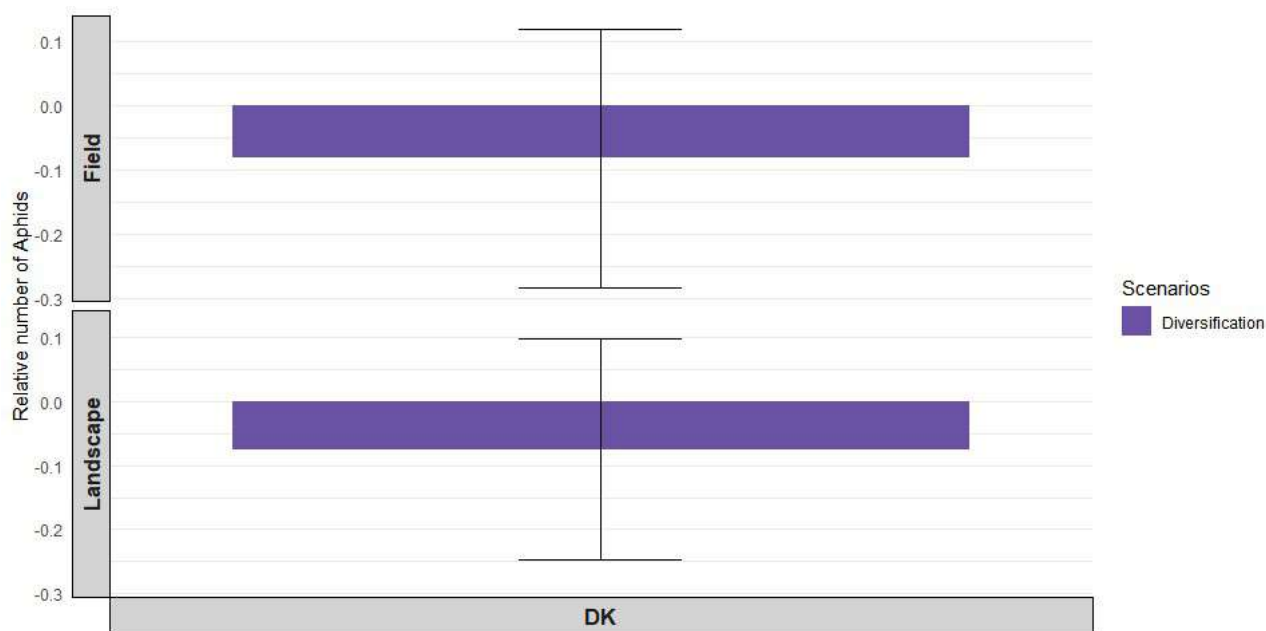


Figure 7.208 Diversification scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Denmark.

7.12.2 Flower field margins

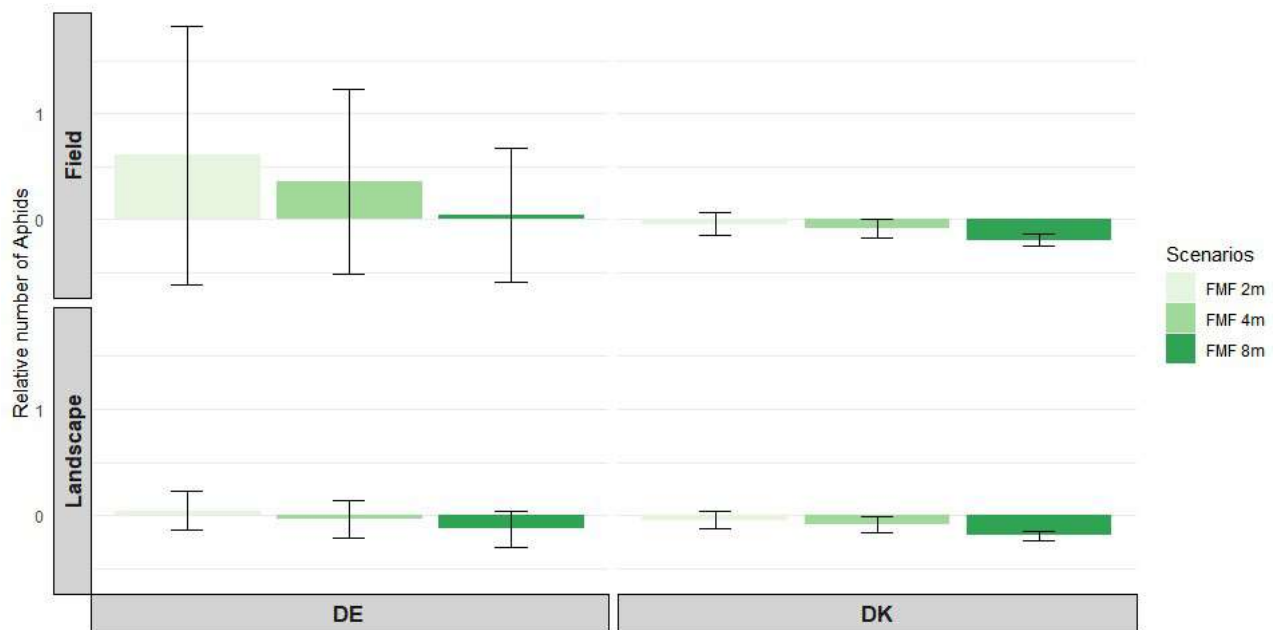


Figure 7.209 Flower field margins with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.3 Grass field margins

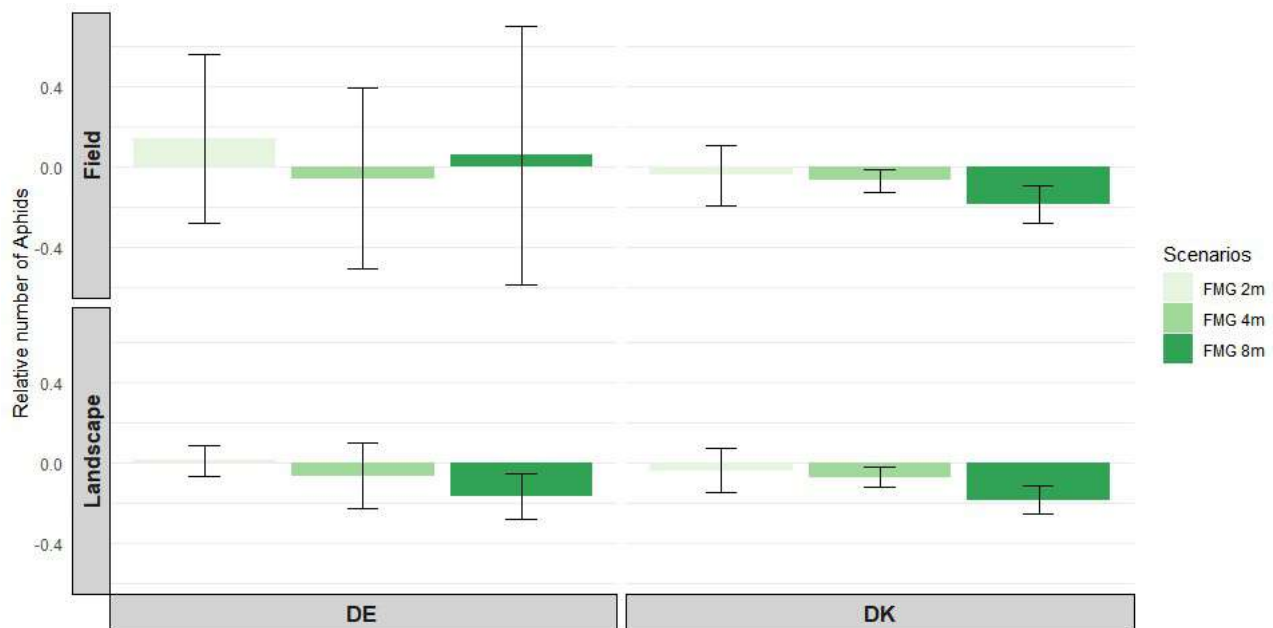


Figure 7.210 Grassy field margins with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.4 Mixed field margins

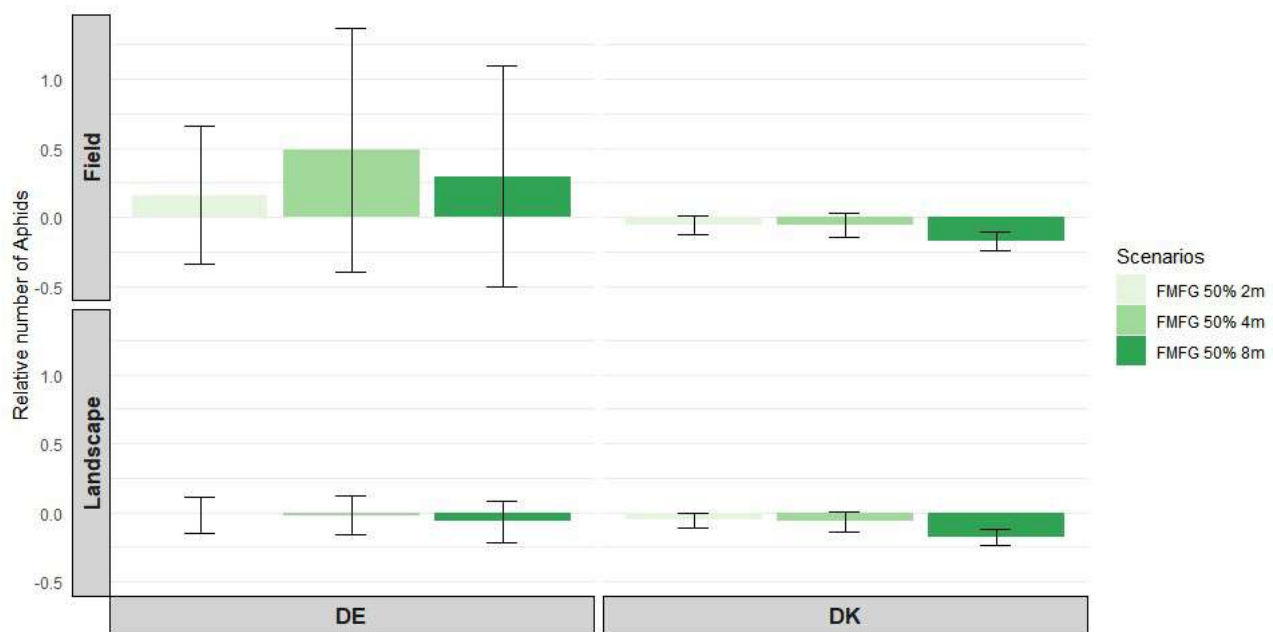


Figure 7.211 Mixed field margins with relative change in the number of female *Pea* aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.5 Flower, grassy and mixed margins

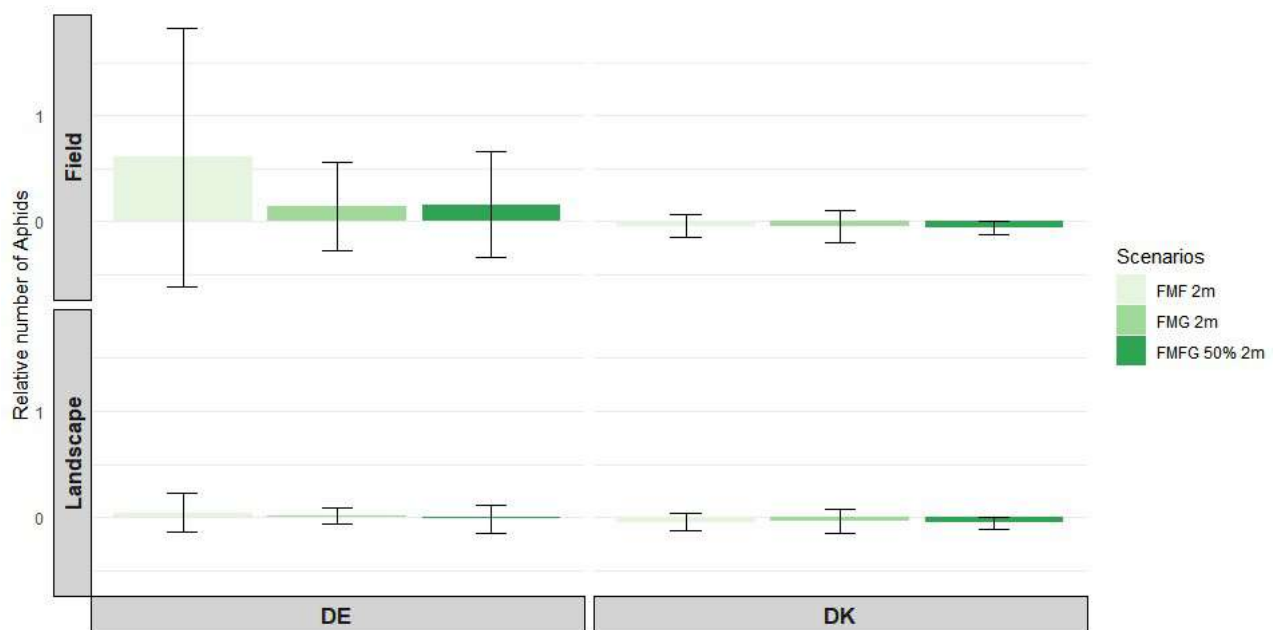


Figure 7.212 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female *Pea* aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

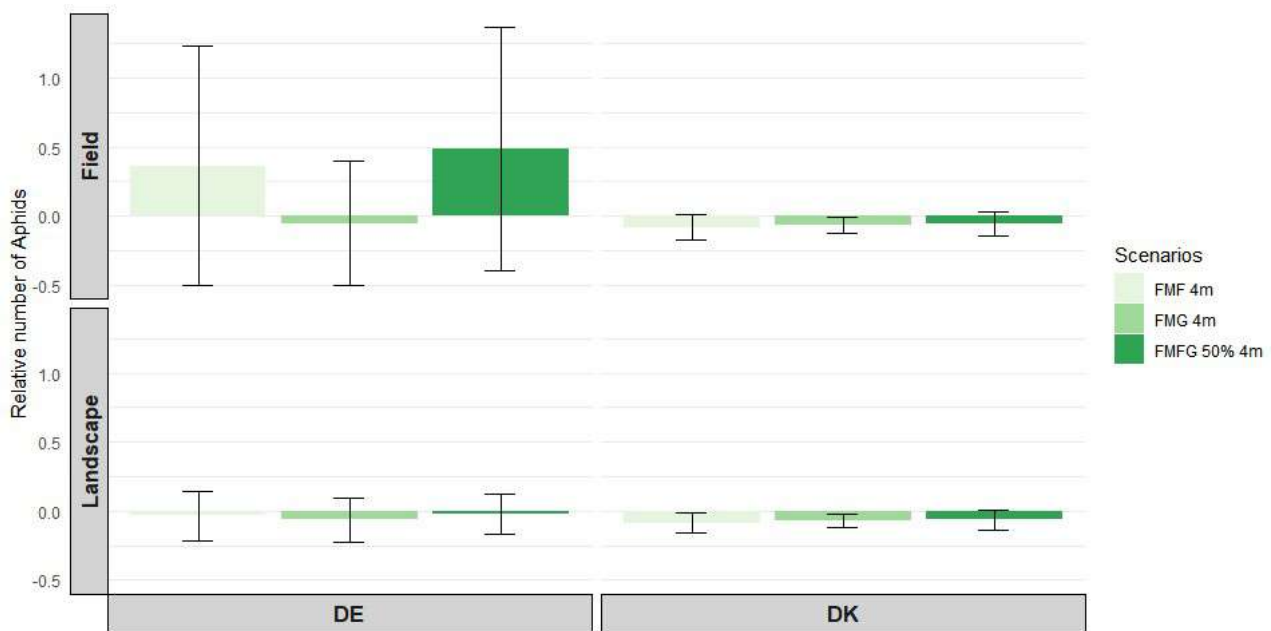


Figure 7.213 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

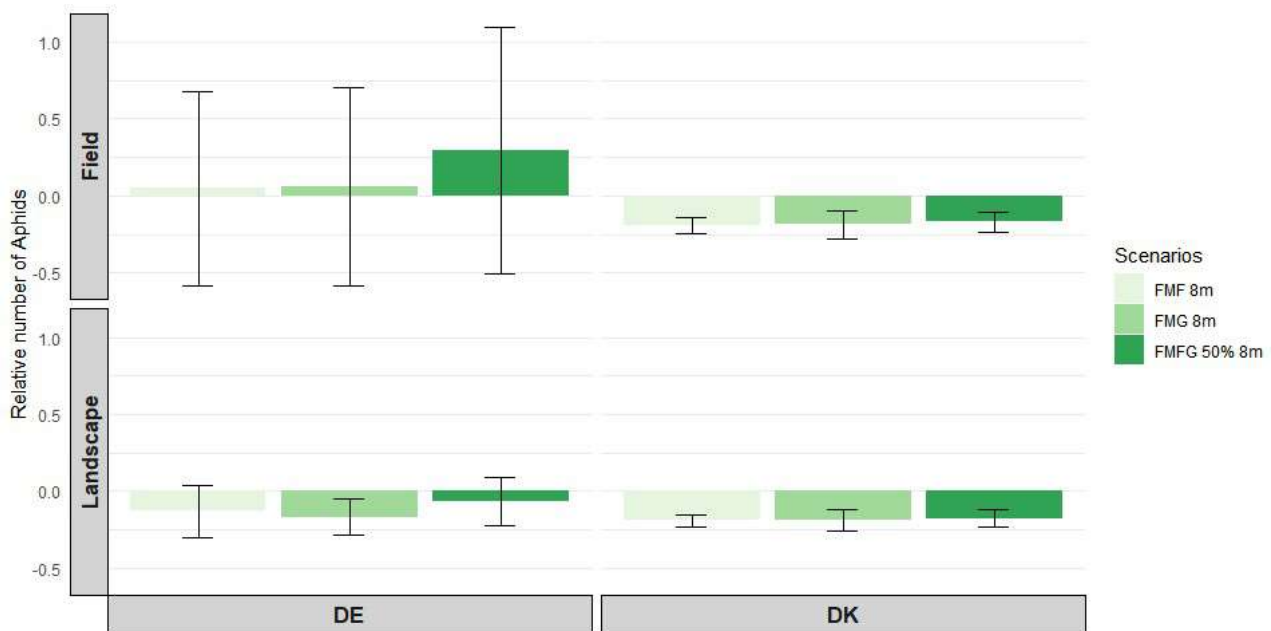


Figure 7.214 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.6 Setaside

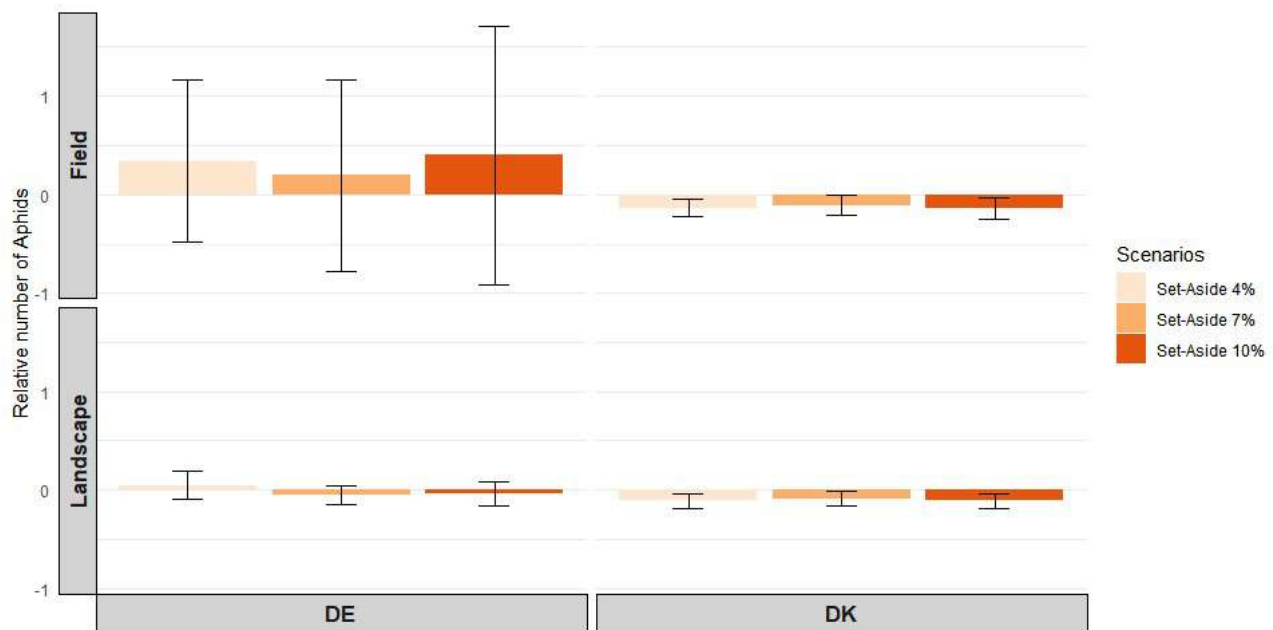


Figure 7.215 Setaside scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.7 Legume

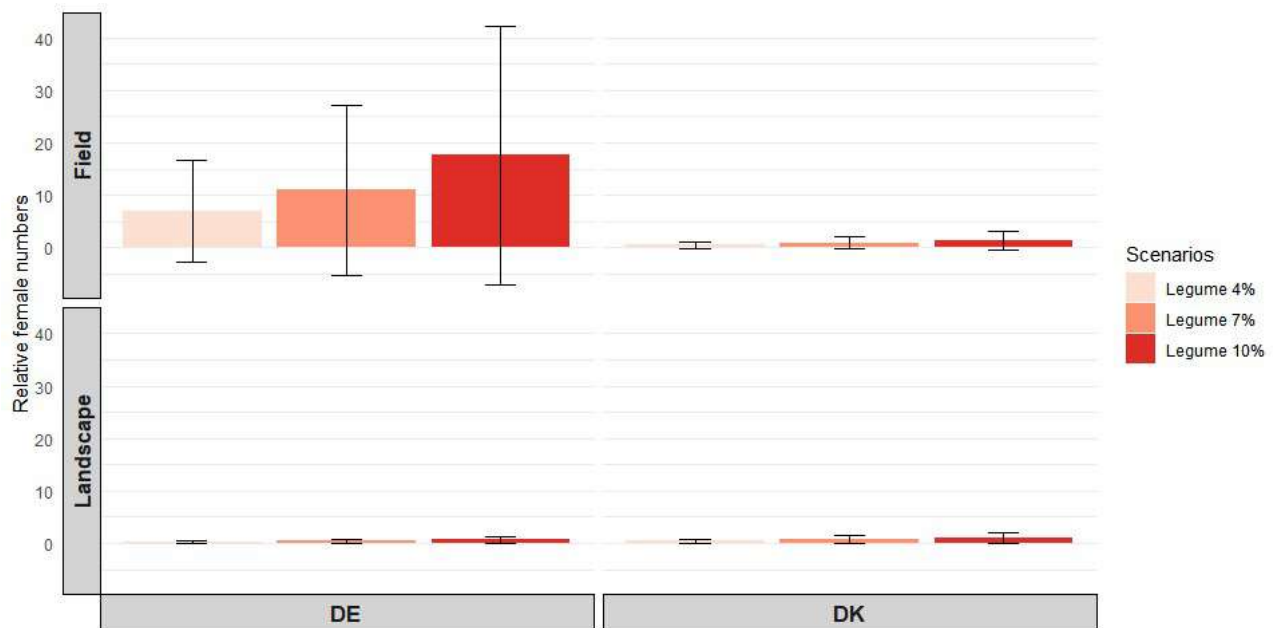


Figure 7.215 Legume scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.8 Biopesticides

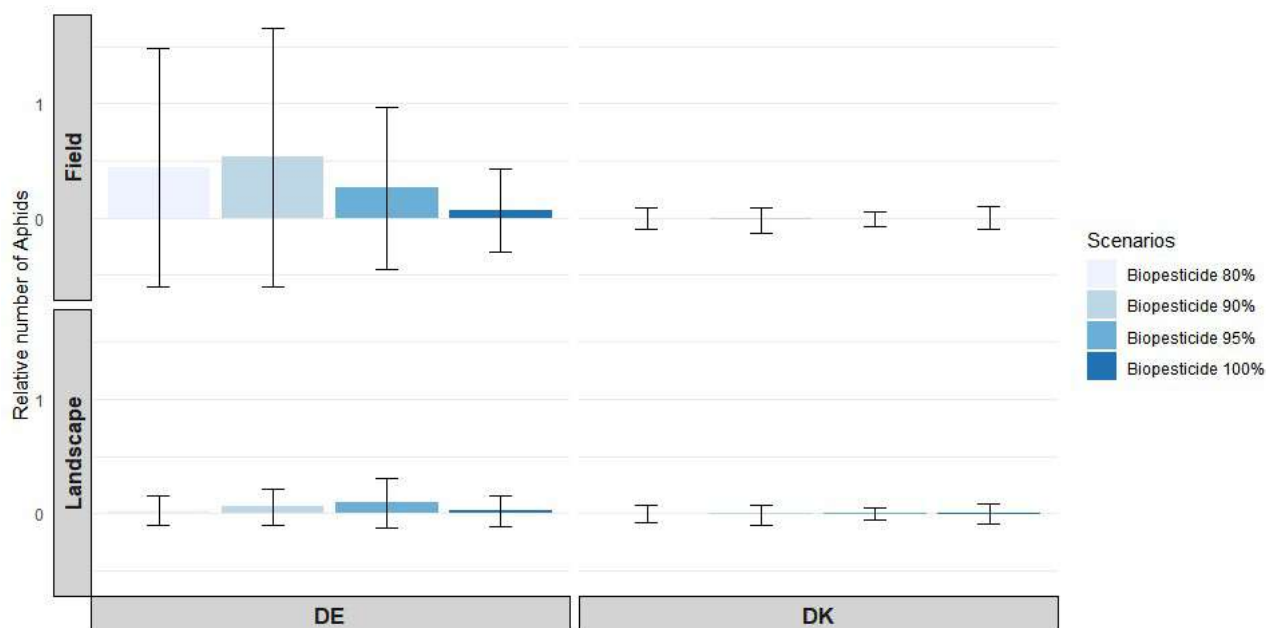


Figure 7.216 Biopesticide scenario with relative change in the number of female Pea aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.12.9 Table of relative change compared to baseline scenarios

Table 7.3 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for Pea aphids. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scale	Scenario	DK	DE
Field	Diversification	-8% (SD 20%)	NA
Landscape	Diversification	-7% (SD 17%)	NA
Field	FMF 2m	-4% (SD 11%)	61% (SD 123%)
Field	FMF 4m	-8% (SD 9%)	36% (SD 87%)
Field	FMF 8m	-19% (SD 5%)	5% (SD 63%)
Landscape	FMF 2m	-5% (SD 8%)	4% (SD 18%)
Landscape	FMF 4m	-8% (SD 8%)	-4% (SD 17%)
Landscape	FMF 8m	-19% (SD 4%)	-13% (SD 17%)
Field	FMG 2m	-4% (SD 15%)	14% (SD 42%)
Field	FMG 4m	-7% (SD 6%)	-6% (SD 45%)
Field	FMG 8m	-19% (SD 9%)	6% (SD 65%)
Landscape	FMG 2m	-4% (SD 11%)	1% (SD 8%)

Scale	Scenario	DK	DE	
Landscape	FMG 4m	-7% (SD 5%)	-6% (SD 16%)	
Landscape	FMG 8m	-19% (SD 7%)	-17% (SD 11%)	
Field	FMFG 50% 2m	-6% (SD 7%)	16% (SD 50%)	
Field	FMFG 50% 4m	-6% (SD 9%)	49% (SD 89%)	
Field	FMFG 50% 8m	-17% (SD 7%)	30% (SD 80%)	
Landscape	FMFG 50% 2m	-6% (SD 5%)	-2% (SD 13%)	
Landscape	FMFG 50% 4m	-6% (SD 7%)	-2% (SD 14%)	
Landscape	FMFG 50% 8m	-18% (SD 6%)	-7% (SD 15%)	
Field	Set-Aside 4%	-13% (SD 9%)	34% (SD 82%)	
Field	Set-Aside 7%	-11% (SD 10%)	19% (SD 97%)	
Field	Set-Aside 10%	-14% (SD 11%)	39% (SD 131%)	
Landscape	Set-Aside 4%	-11% (SD 8%)	5% (SD 15%)	
Landscape	Set-Aside 7%	-8% (SD 7%)	-4% (SD 9%)	
Landscape	Set-Aside 10%	-11% (SD 8%)	-4% (SD 12%)	
Field	Legume 4%	56% (SD 60%)	706% (SD 969%)	485
Field	Legume 7%	98% (SD 112%)	1104% (SD 1619%)	
Field	Legume 10%	136% (SD 168%)	1759% (SD 2475%)	
Landscape	Legume 4%	43% (SD 40%)	30% (SD 33%)	
Landscape	Legume 7%	75% (SD 74%)	41% (SD 41%)	
Landscape	Legume 10%	103% (SD 112%)	69% (SD 68%)	
Field	Biopesticide 80%	-1% (SD 9%)	44% (SD 104%)	
Field	Biopesticide 90%	-2% (SD 11%)	53% (SD 113%)	
Field	Biopesticide 95%	-1% (SD 7%)	26% (SD 71%)	
Field	Biopesticide 100%	-0% (SD 10%)	6% (SD 36%)	
Landscape	Biopesticide 80%	-0% (SD 7%)	3% (SD 13%)	
Landscape	Biopesticide 90%	-1% (SD 9%)	6% (SD 16%)	
Landscape	Biopesticide 95%	-1% (SD 5%)	10% (SD 22%)	
Landscape	Biopesticide 100%	-0% (SD 8%)	2% (SD 13%)	

7.D PEACH POTATO APHID

7.13 Baselines across countries

7.13.1 Whole landscape

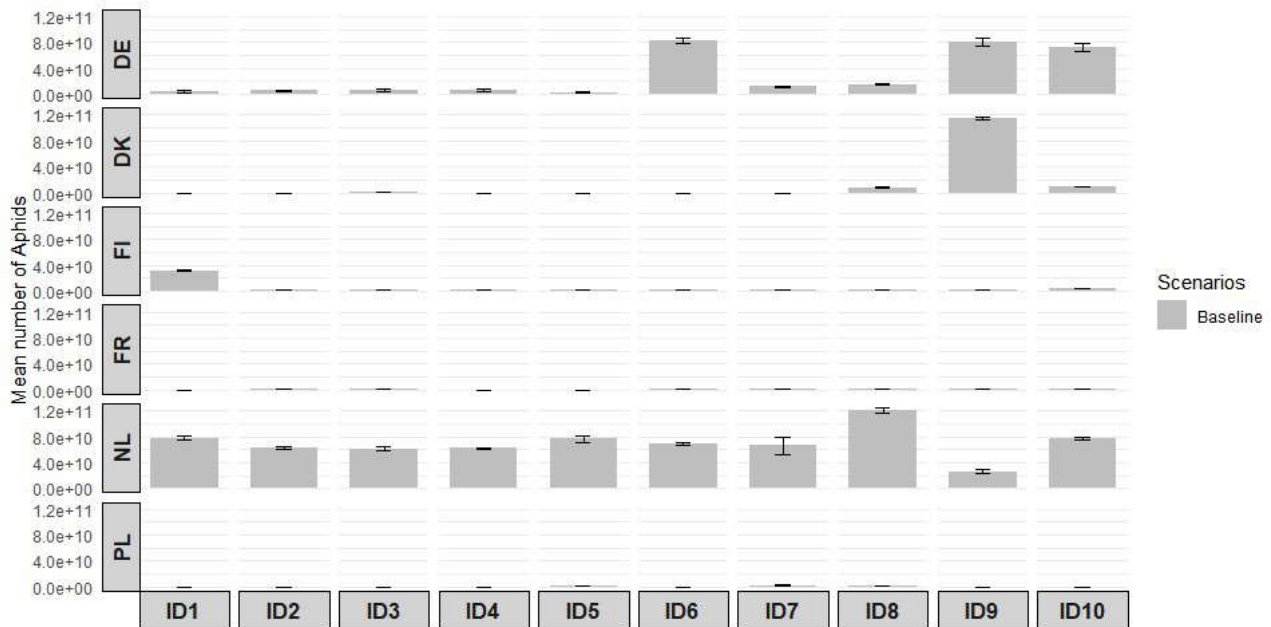


Figure 7.217: Peach potato aphid baselines for each country and landscape.

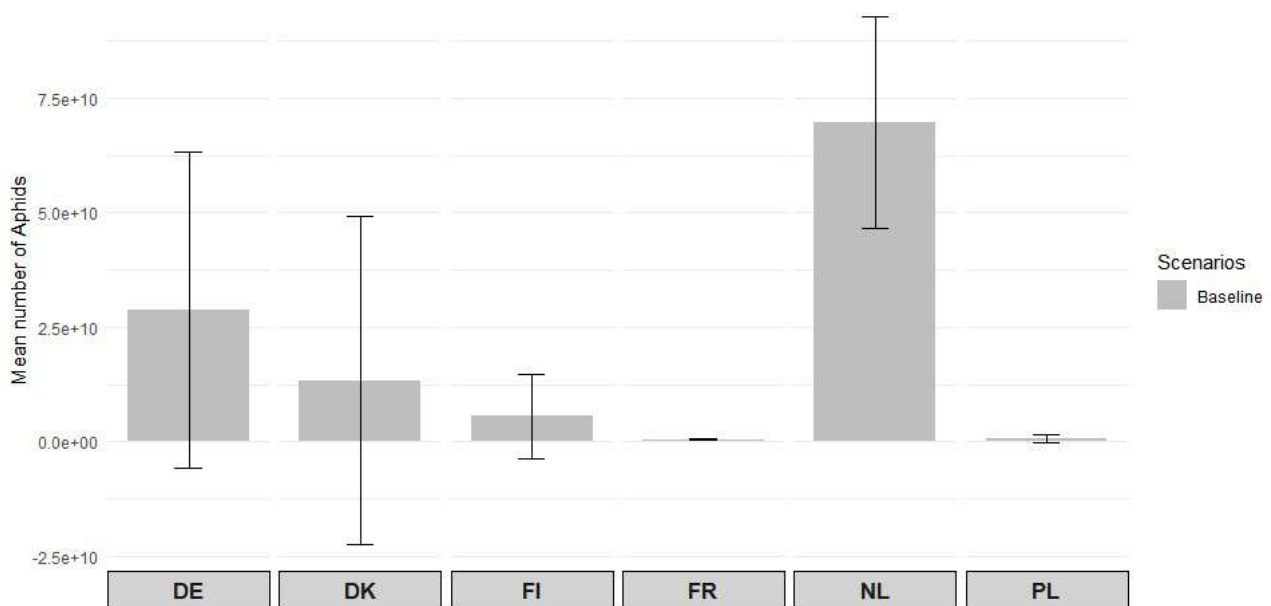


Figure 7.218: Peach potato aphid baselines for each country combined across landscapes.

7.13.2 In-field

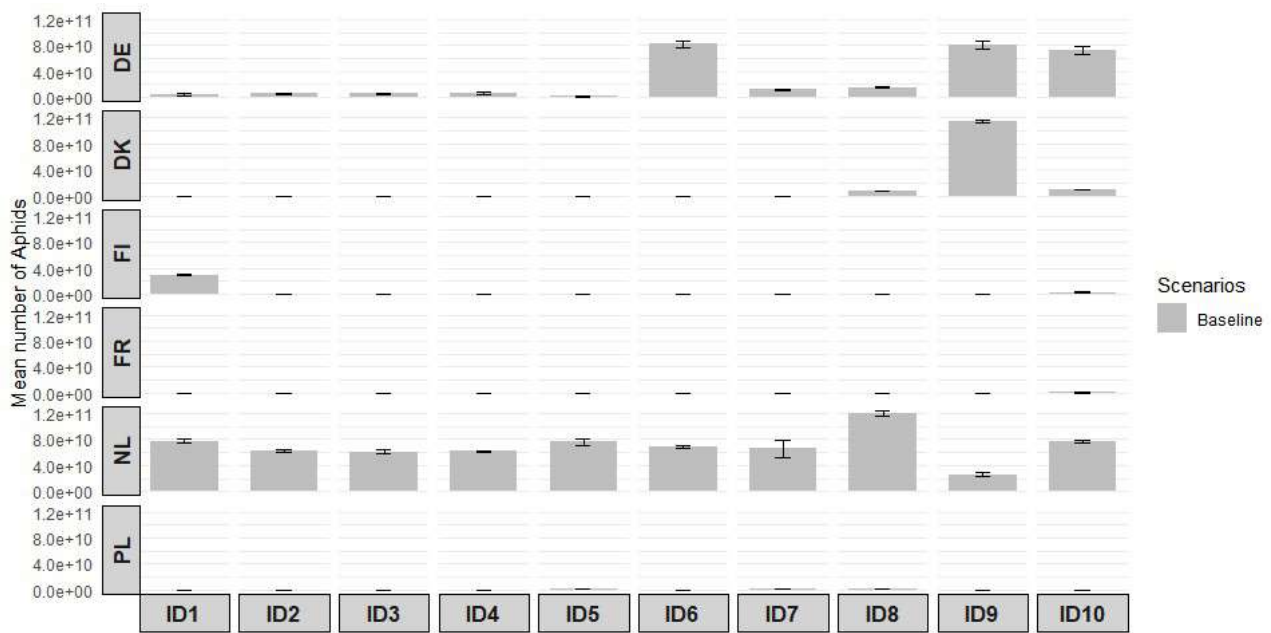


Figure 7.219: Peach potato aphid baselines for each country and landscape. Peach potato aphids in the fields only.

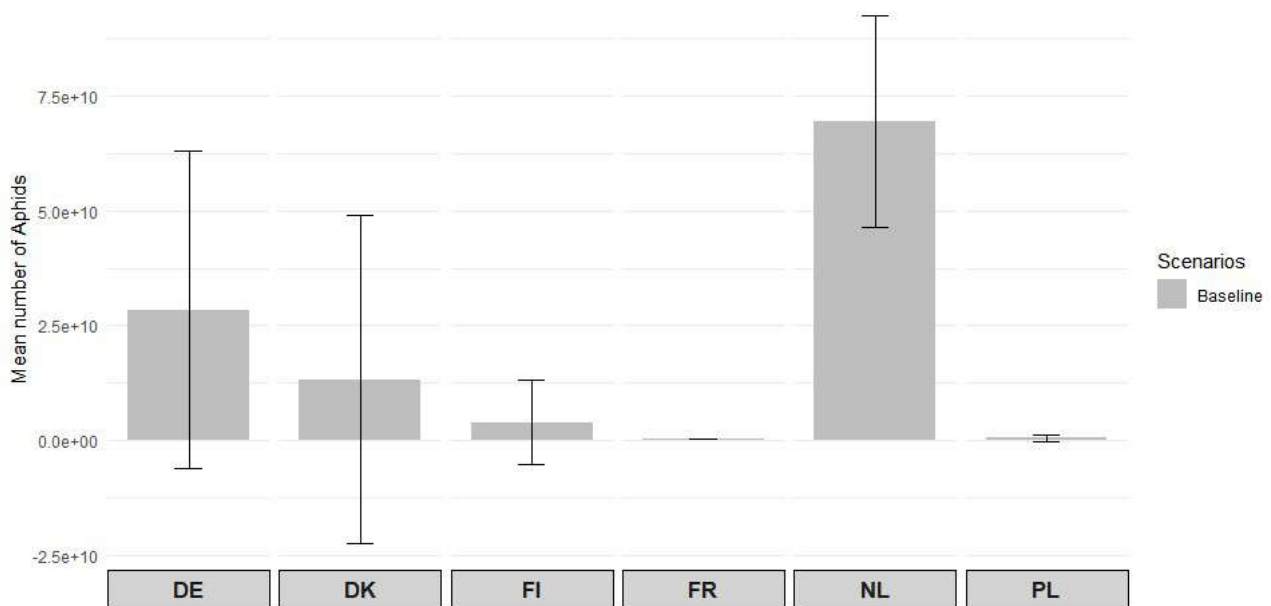


Figure 7.220: Peach potato aphid baselines for each country combined across landscapes. Peach potato aphids in the fields only.

7.13.3 In-field relative to landscape

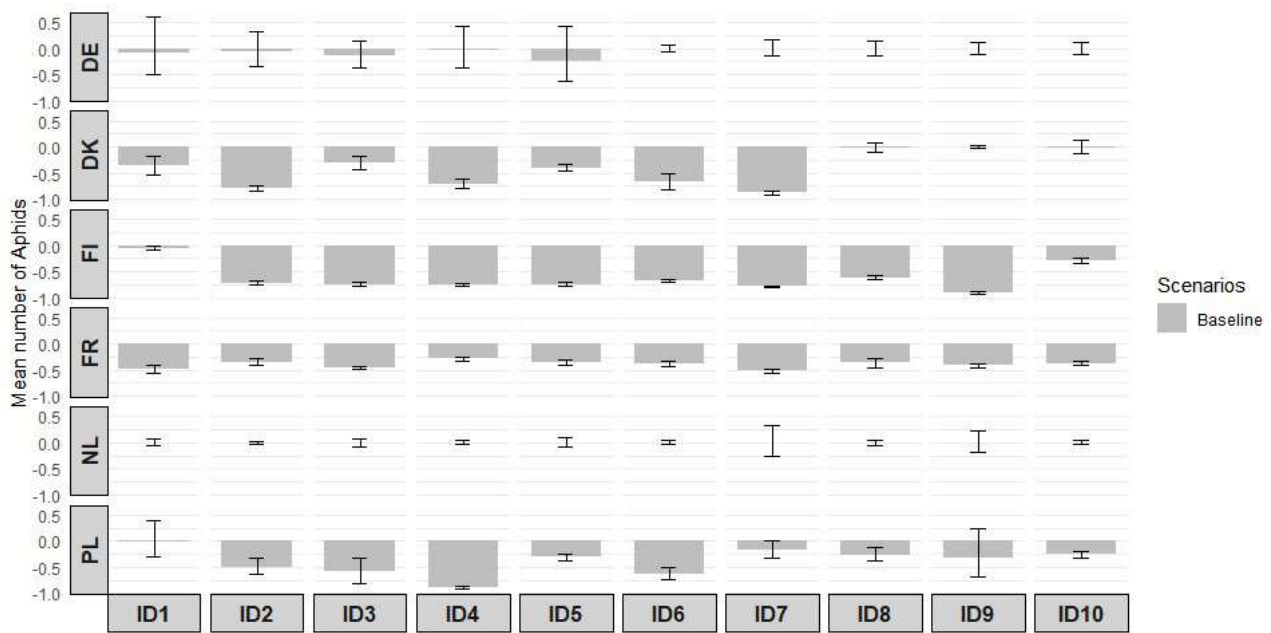


Figure 7.221 In-field relative to whole landscape comparison of Peach potato aphid baseline runs across countries and landscapes.

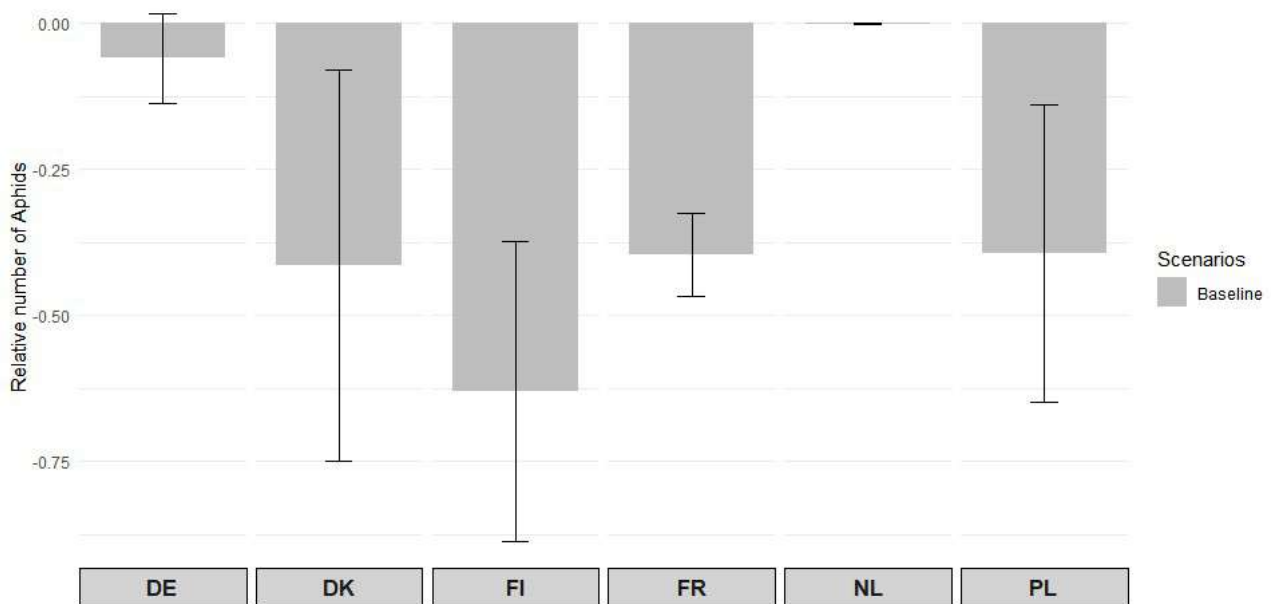


Figure 7.222 In-field relative to whole landscape comparison of Peach potato aphid baseline for each country across landscapes.

7.14 Germany

7.14.1 Flower field margins

7.14.1.1 Whole landscape

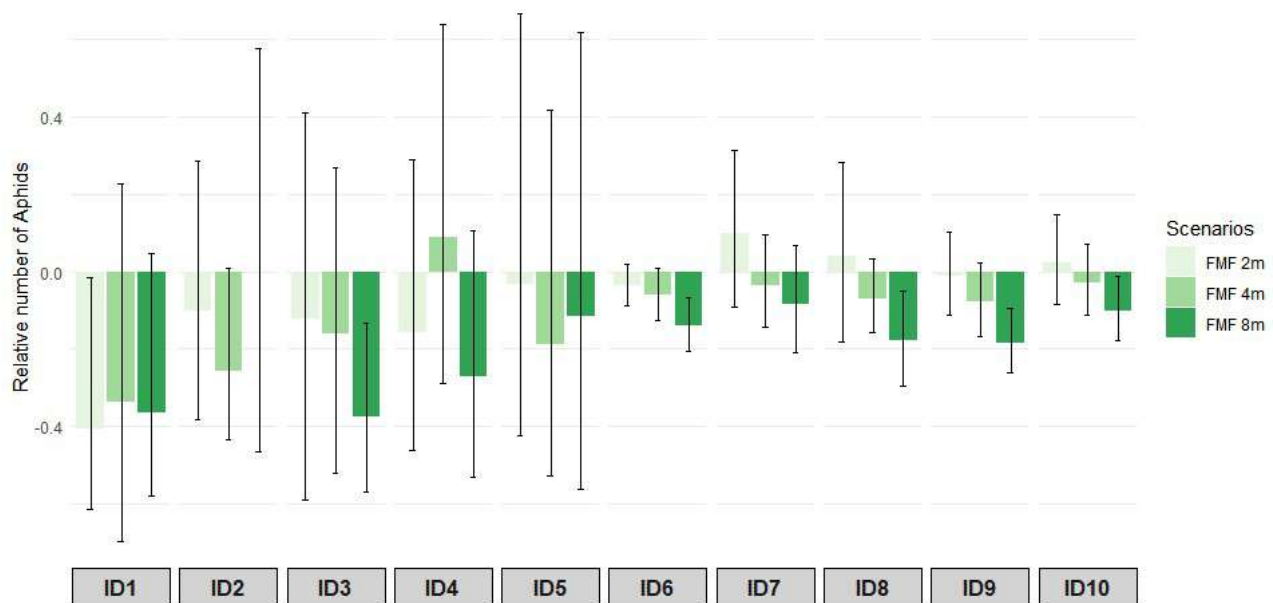


Figure 7.223 Flower field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.1.2 In-field

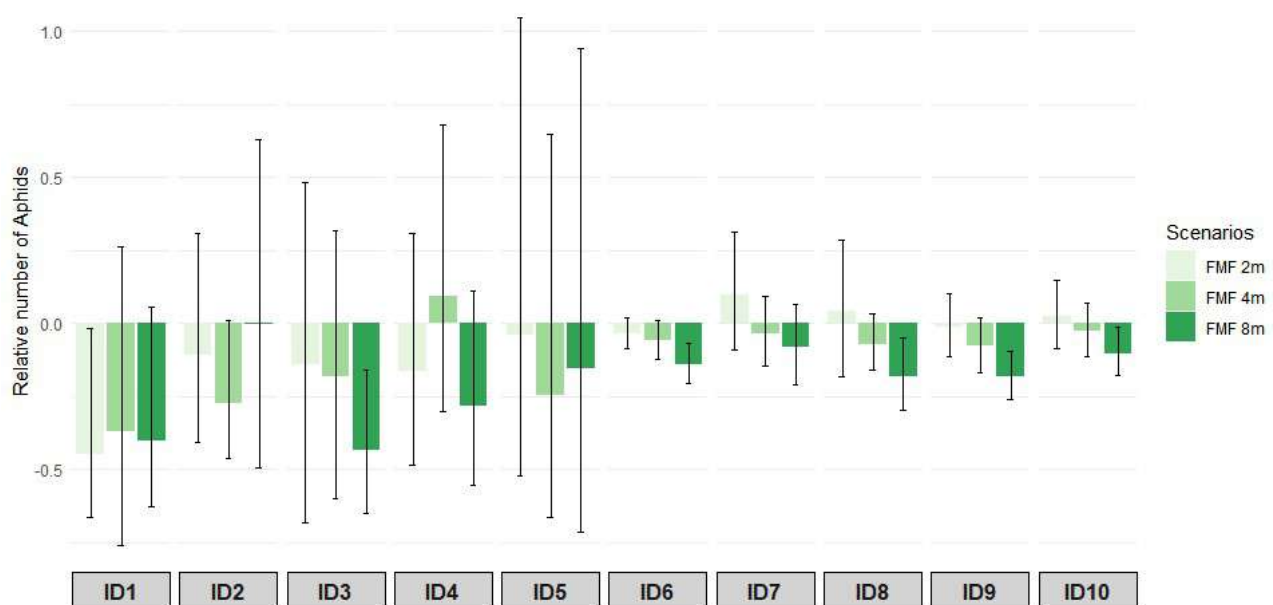


Figure 7.224 Flower field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.1.3 In-field relative to landscape

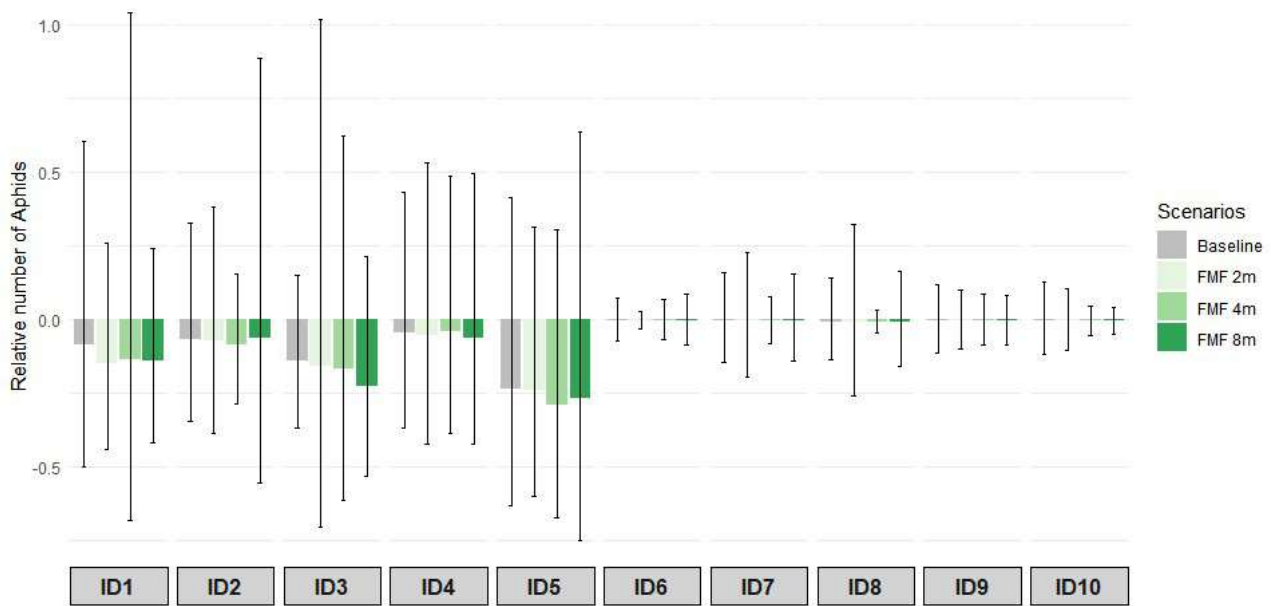


Figure 7.225 Flower field margins scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.14.2 Grass field margins

7.14.2.1 Whole landscape

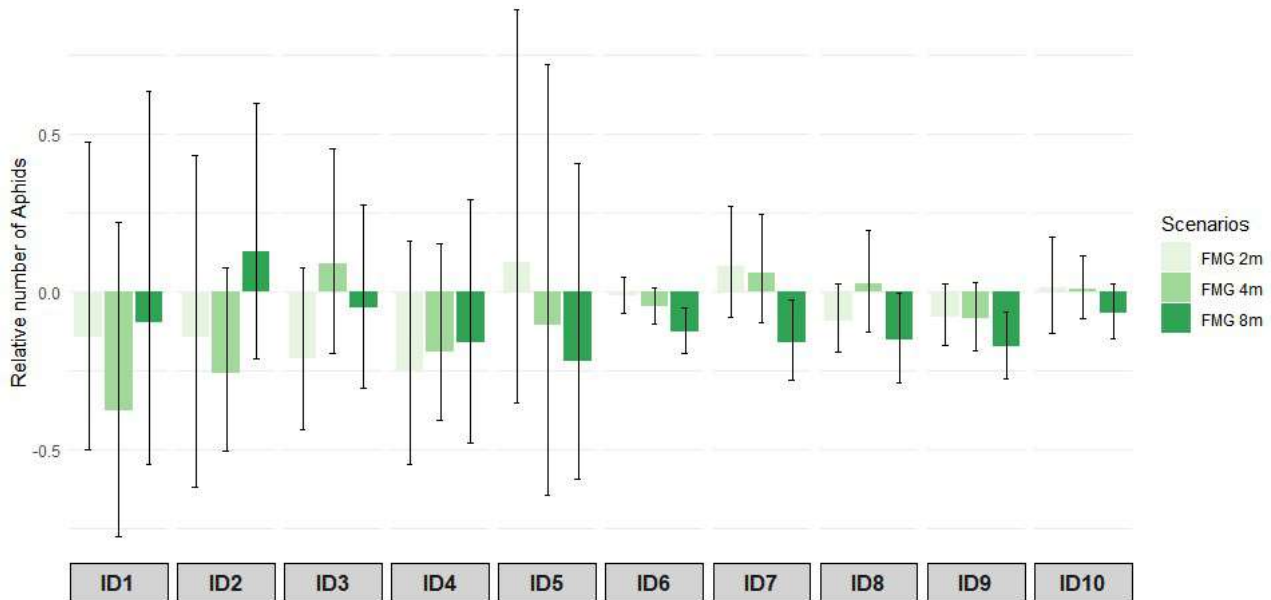


Figure 7.226 Grassy field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.2.2 In-field

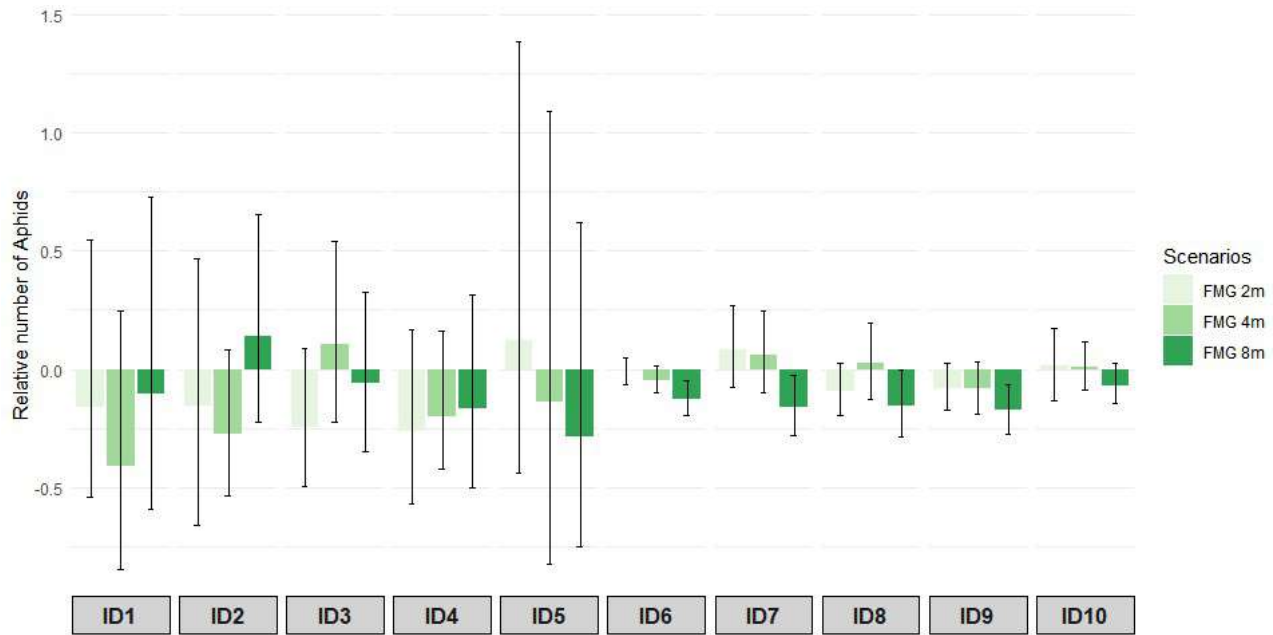


Figure 7.227 Grassy field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.2.3 In-field relative to landscape

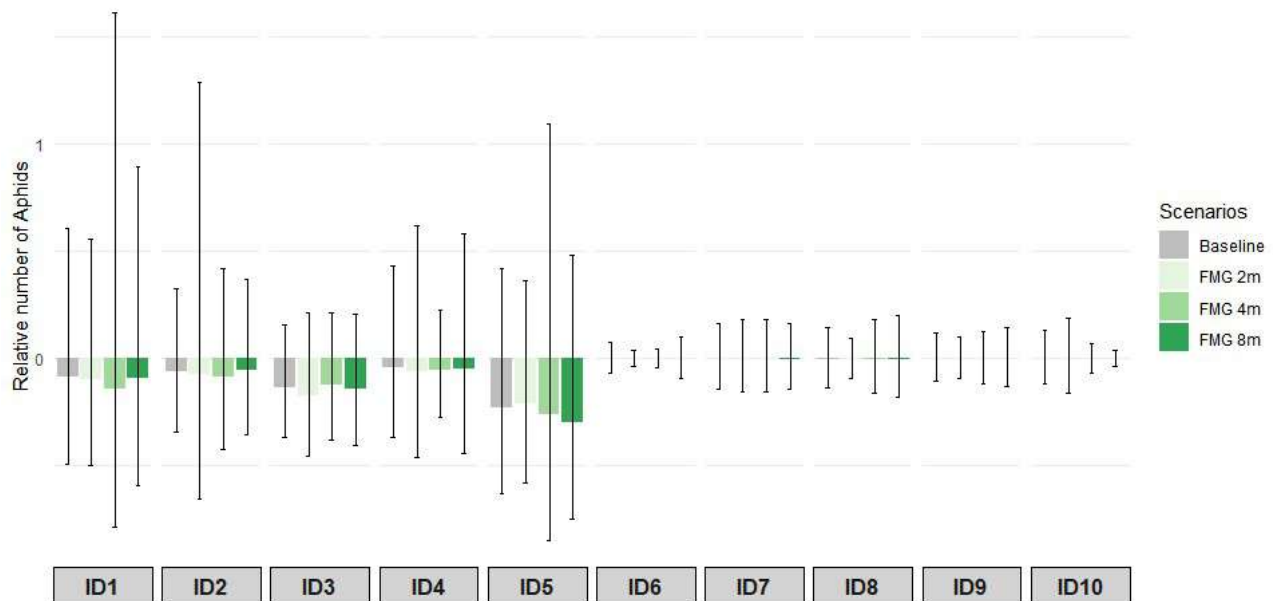


Figure 7.228 Grassy field margins scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.14.3 Mixed field margins

7.14.3.1 Whole landscape

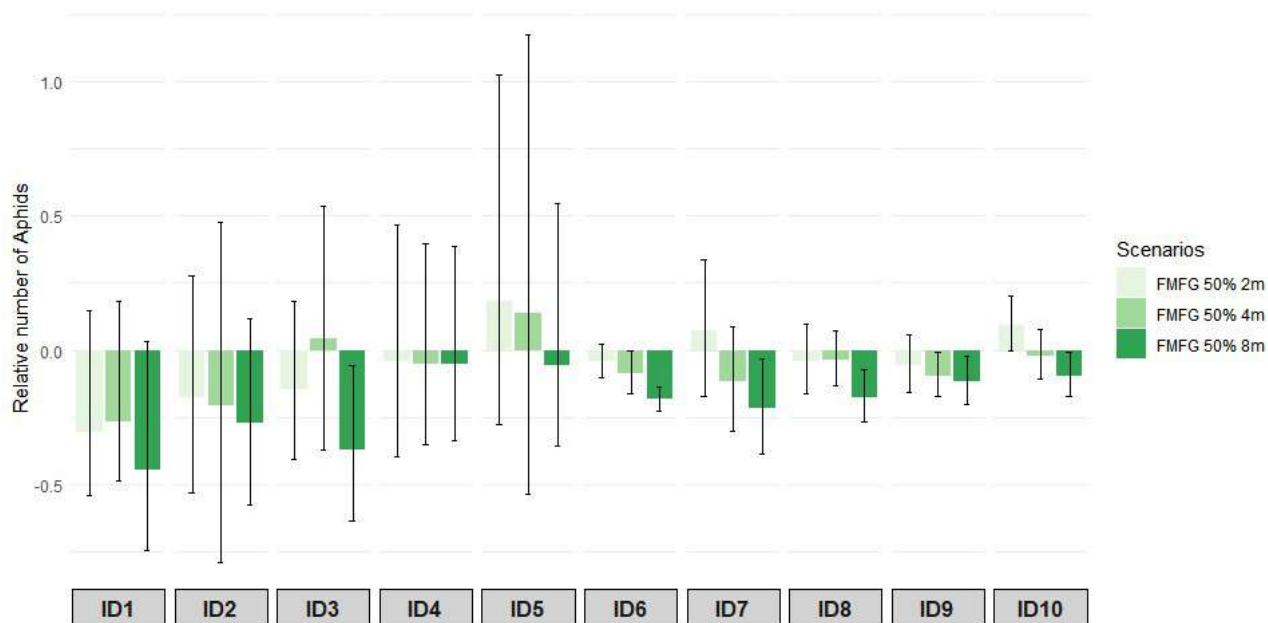


Figure 7.229 Mixed field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.3.2 In-field

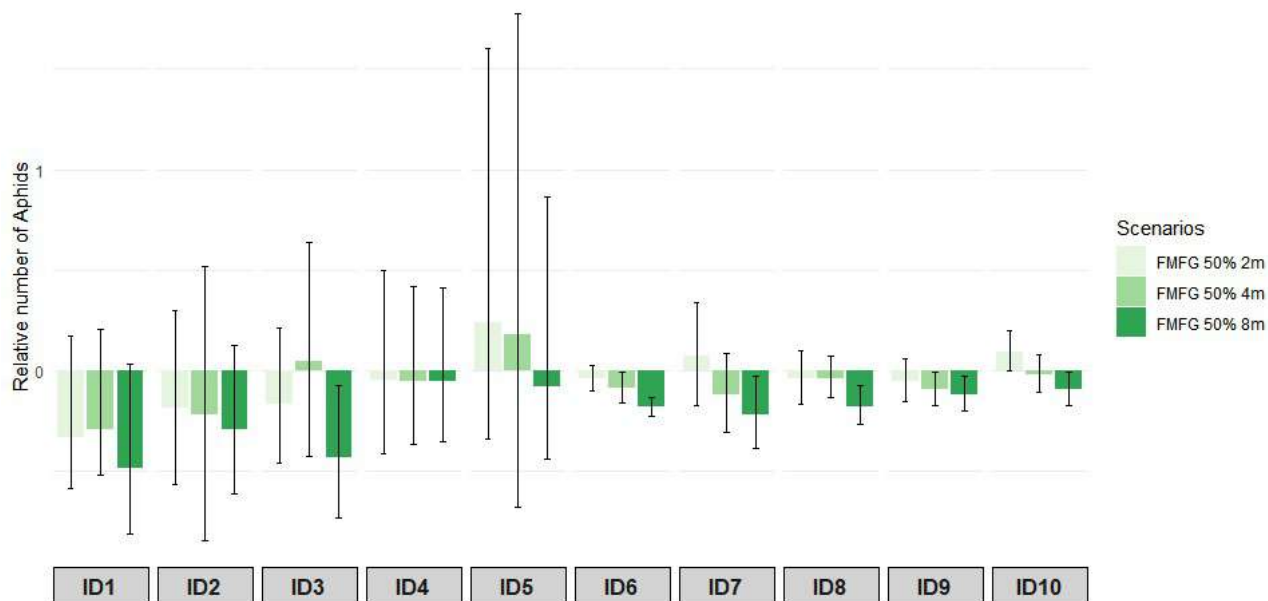


Figure 7.230 Mixed field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.3.3 In-field relative to landscape

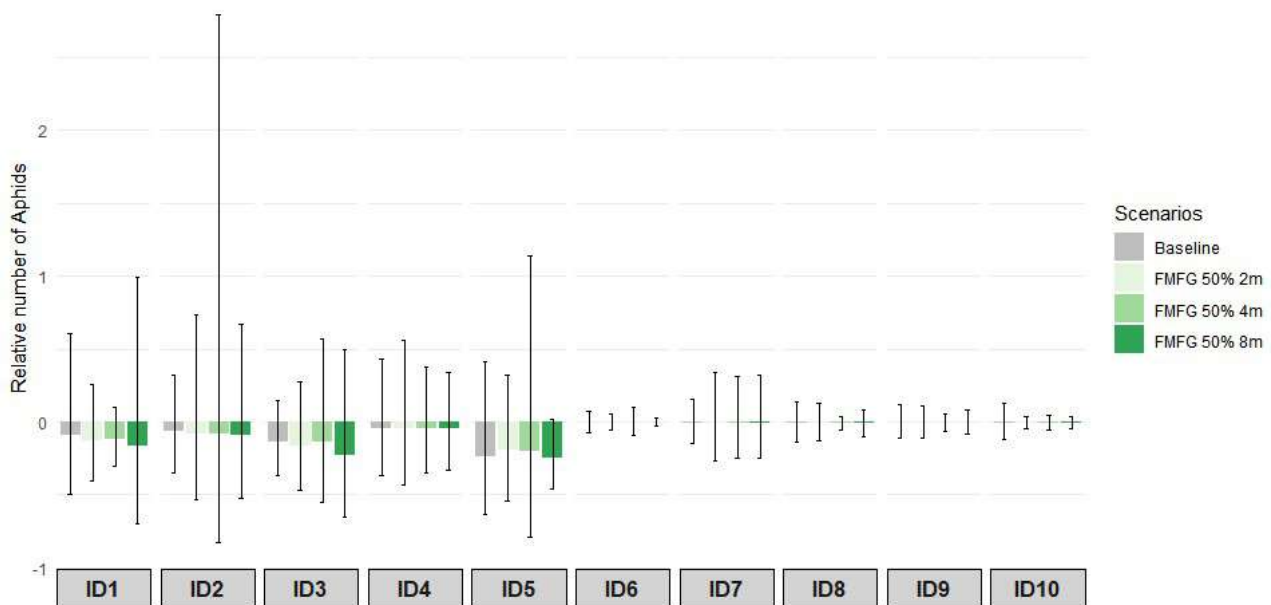


Figure 7.231 Mixed field margins scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.14.4 Flower, grassy and mixed margins

7.14.4.1 Whole landscape

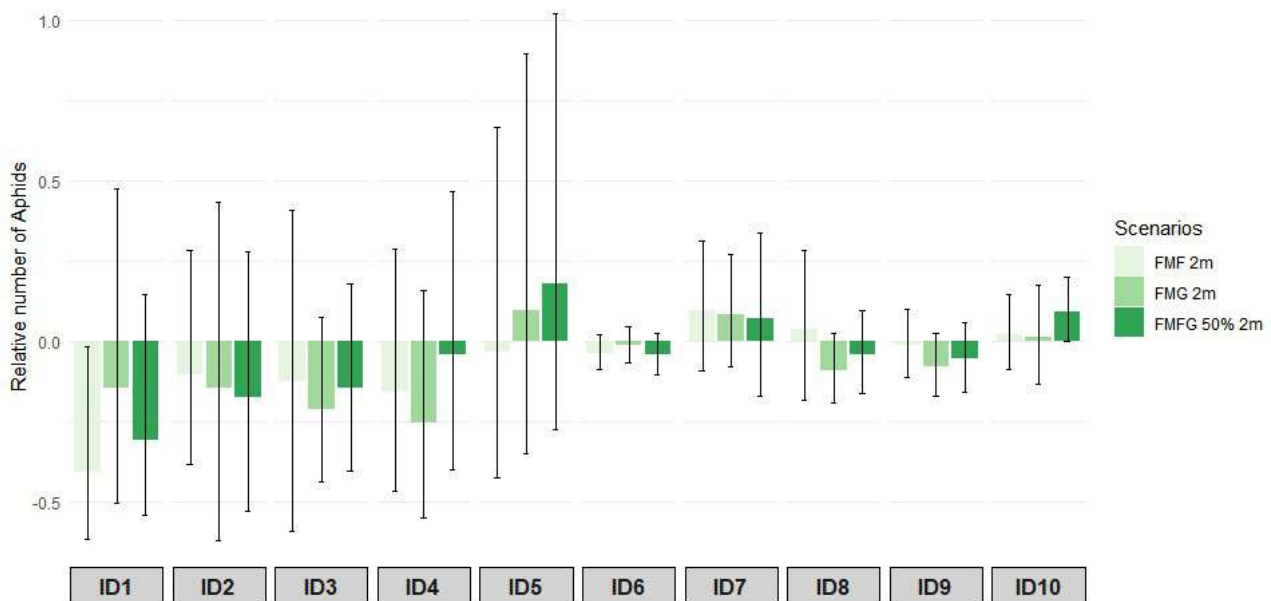


Figure 7.232 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

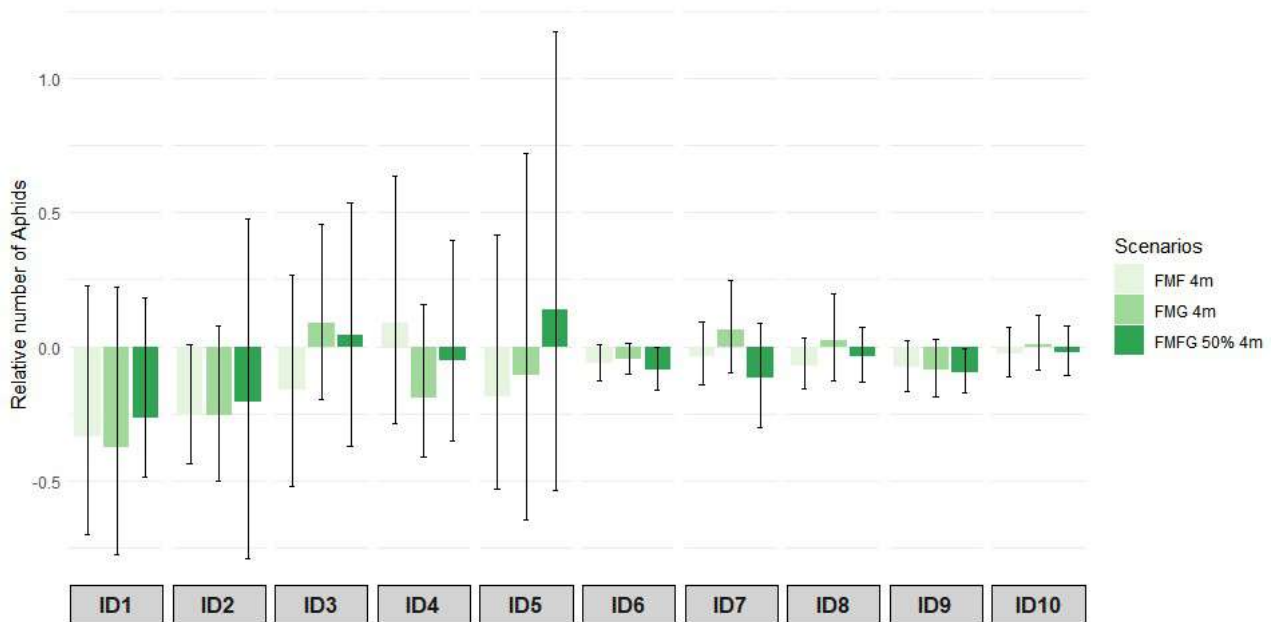


Figure 7.233 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

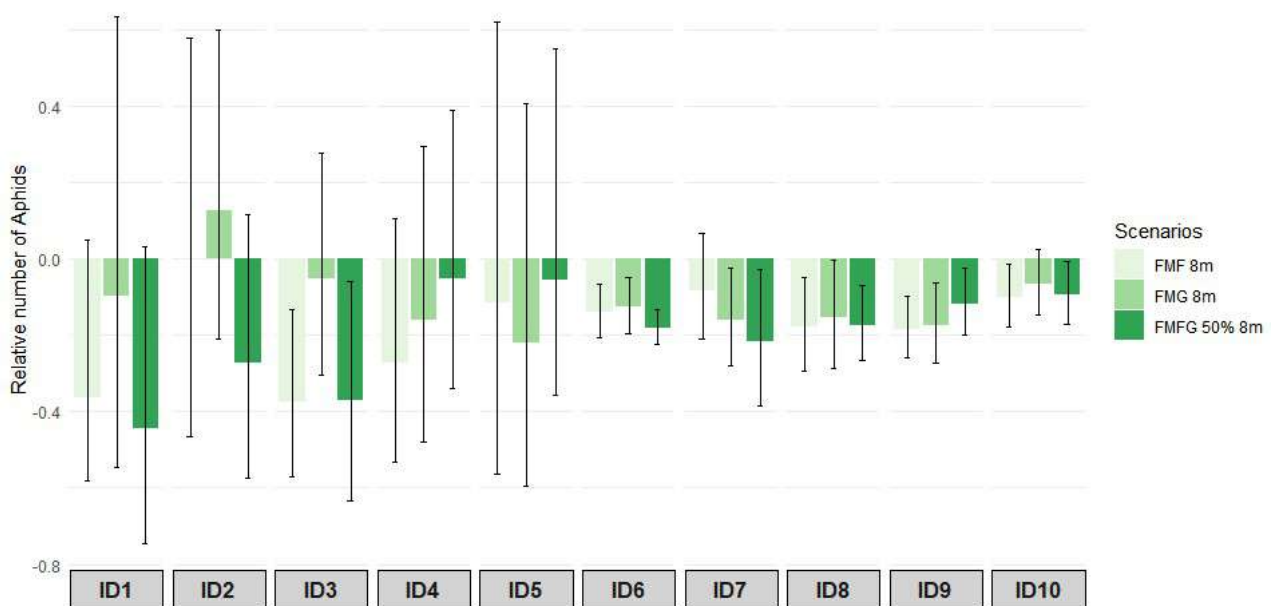


Figure 7.234 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.4.2 In-field

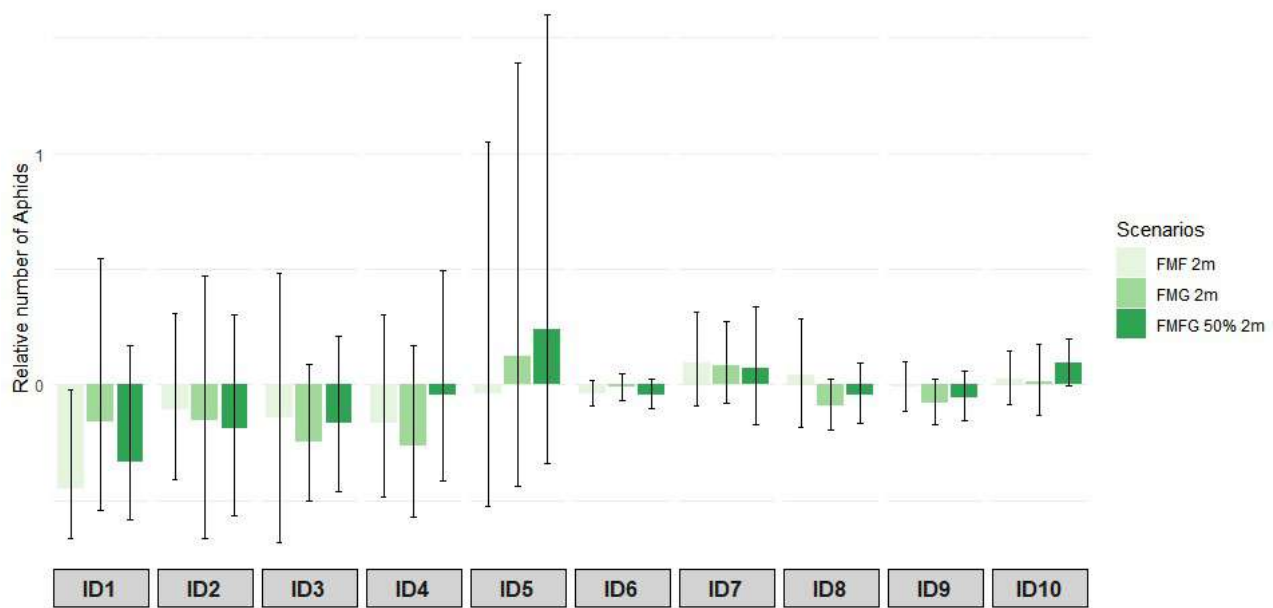


Figure 7.235 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

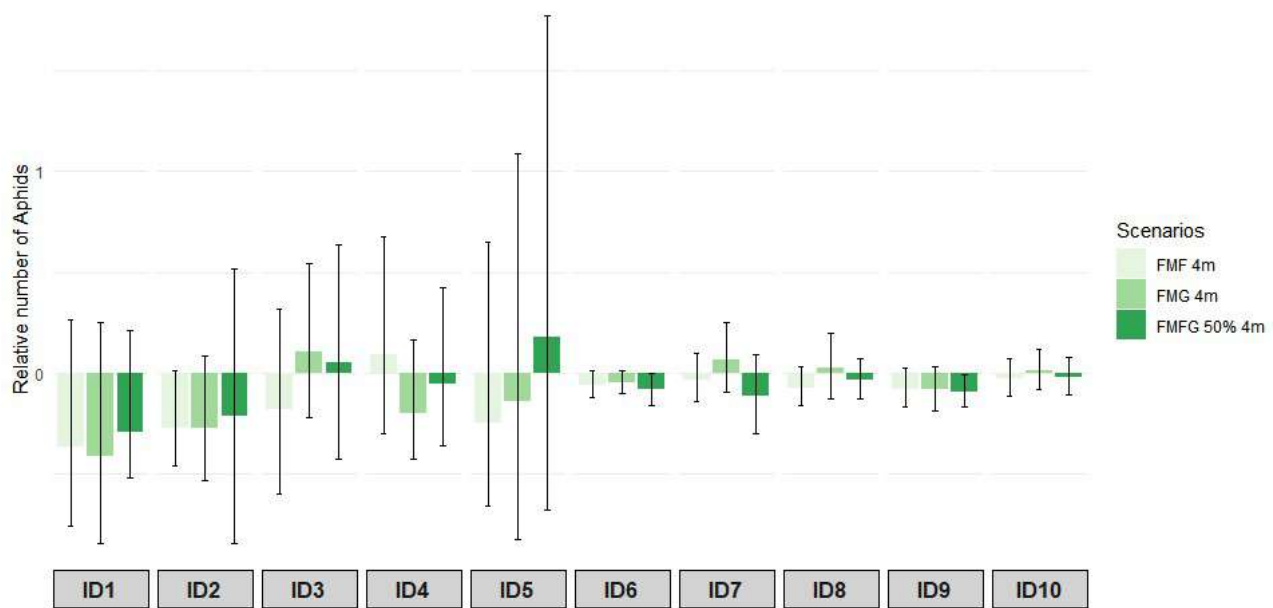


Figure 7.236 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

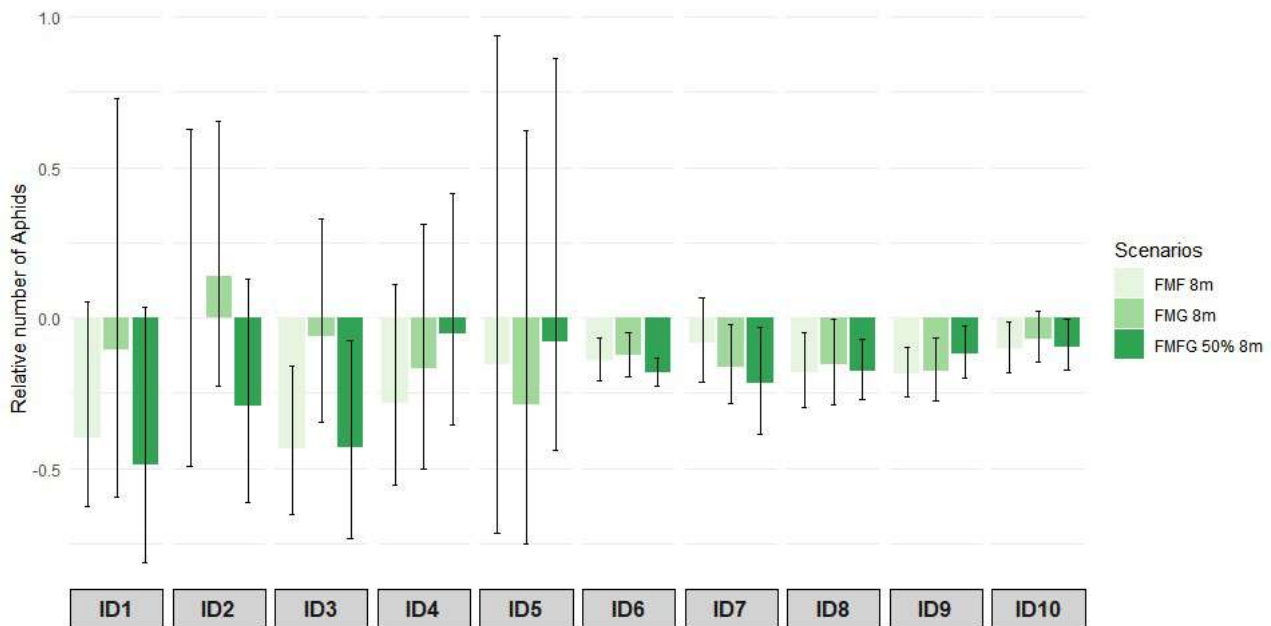


Figure 7.237 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.4.3 In-field relative to landscape

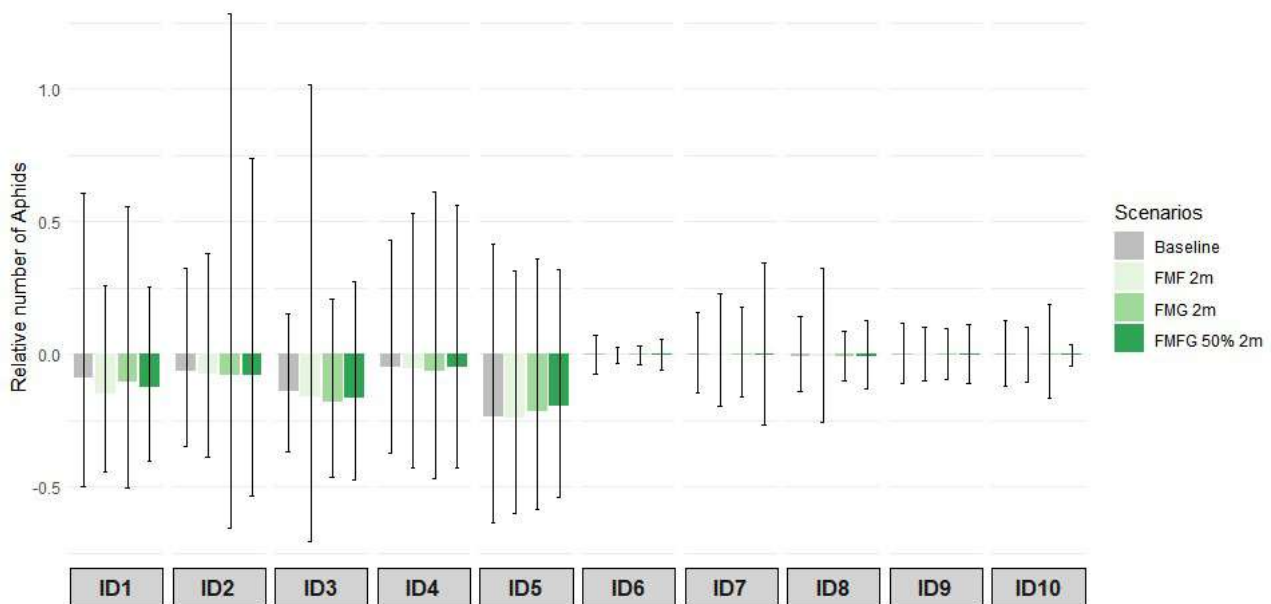


Figure 7.238 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

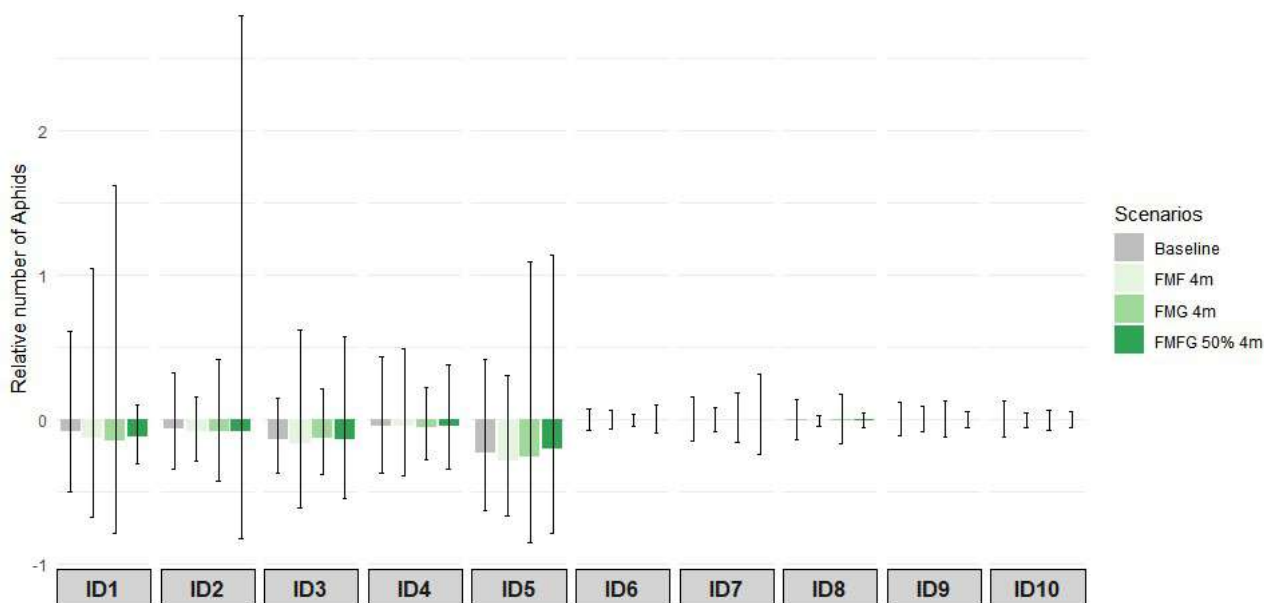


Figure 7.239 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

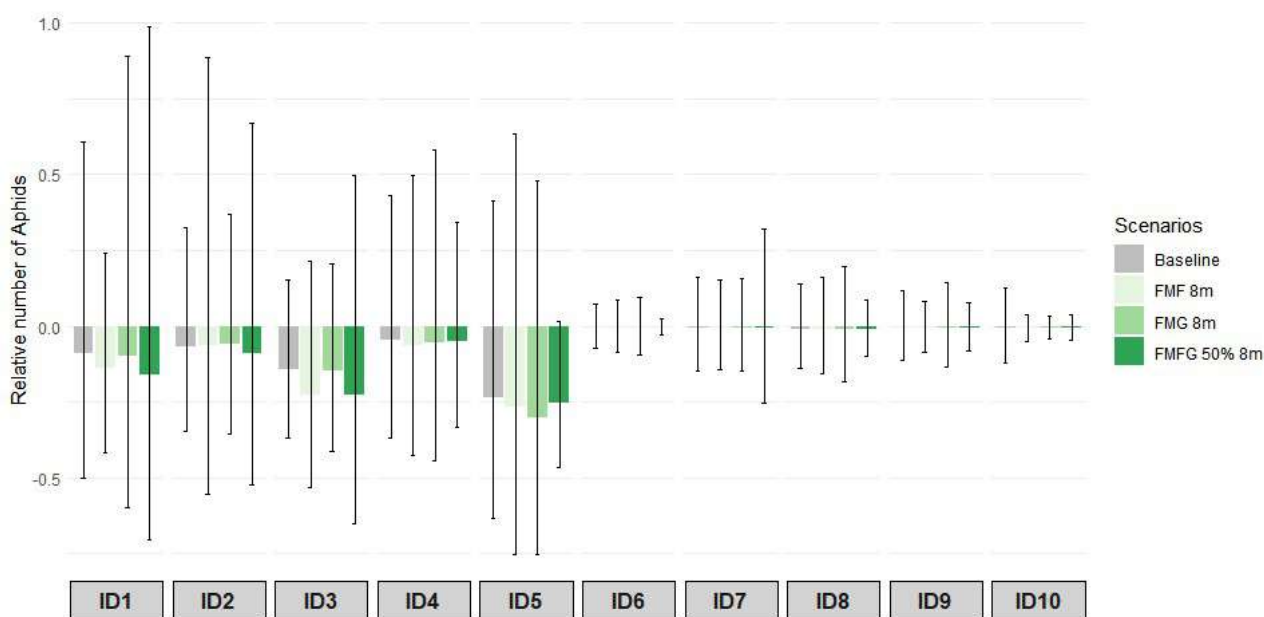


Figure 7.240 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.14.5 Setaside

7.14.5.1 Whole landscape

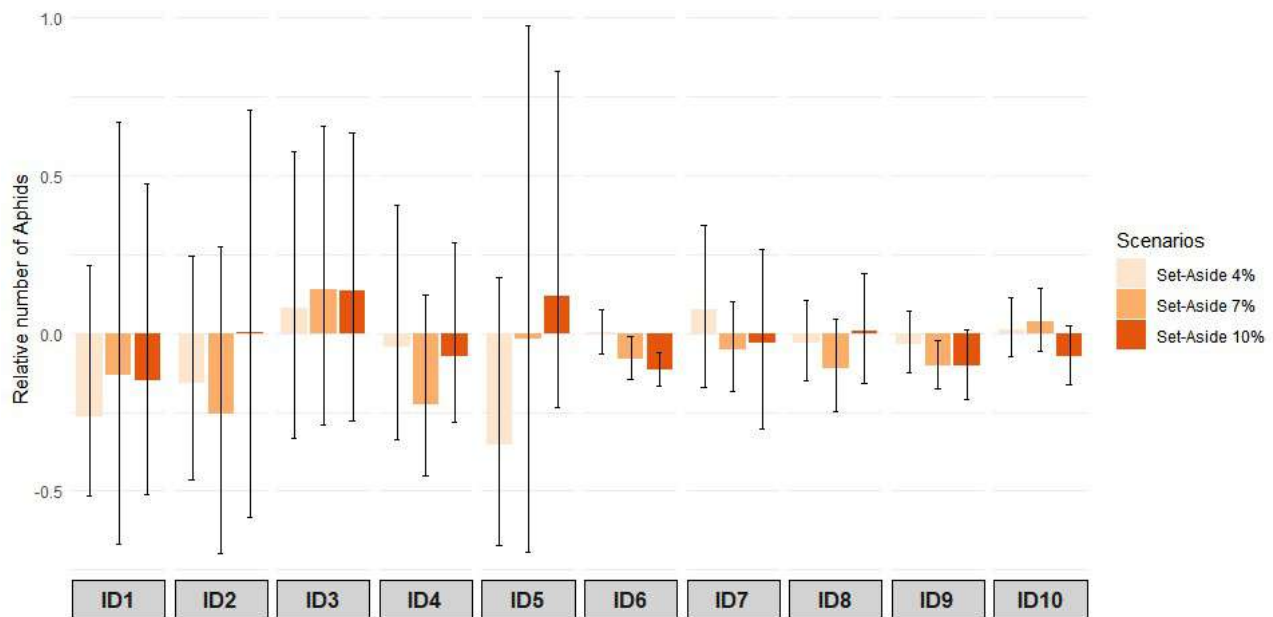


Figure 7.241 Setaside scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.5.2 In-field

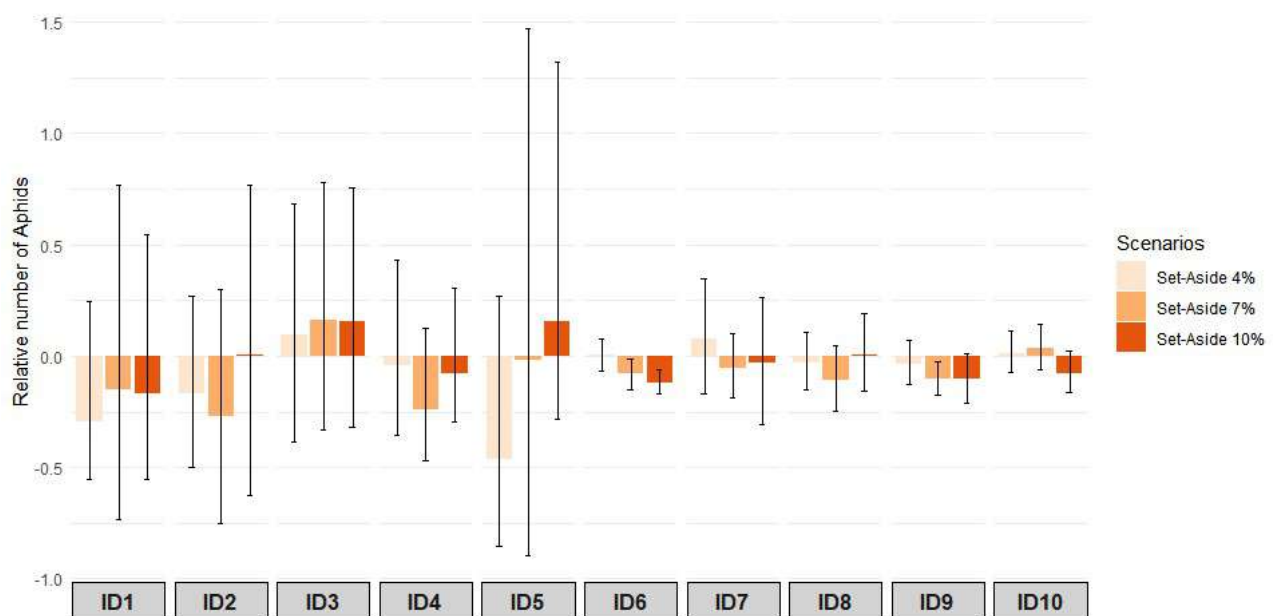


Figure 7.242 Setaside scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.5.3 In-field relative to landscape

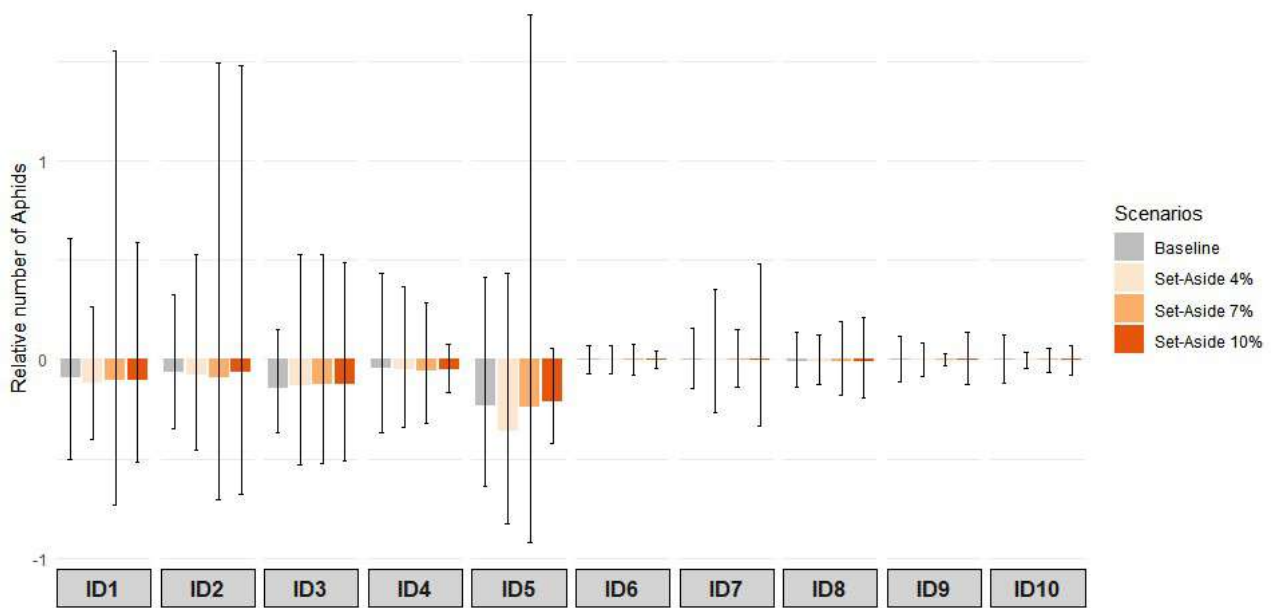


Figure 7.243 Setaside scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.14.6 Legume

7.14.6.1 Whole landscape

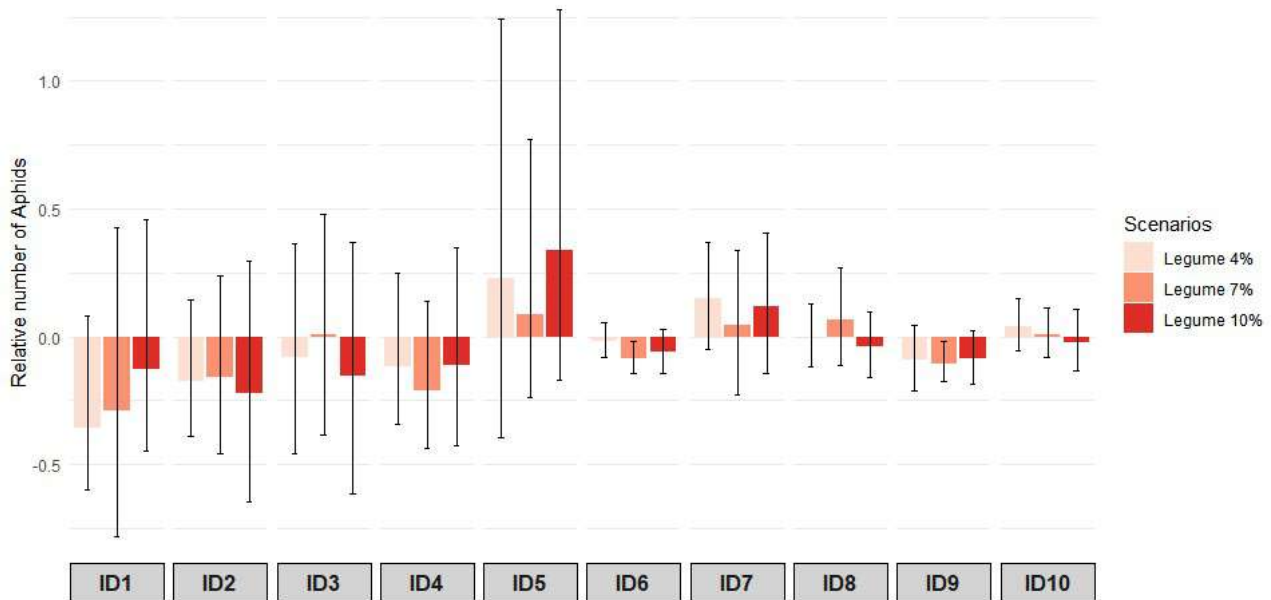


Figure 7.244 Legume scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.6.2 In-field

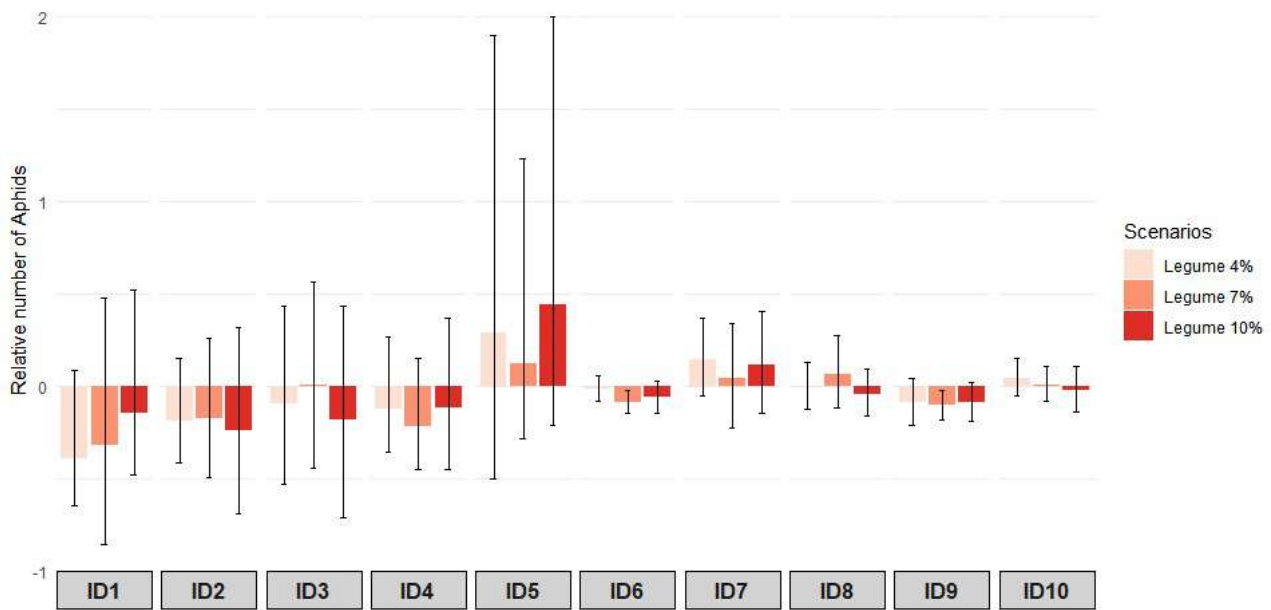


Figure 7.245 Legume scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.6.3 In-field relative to landscape

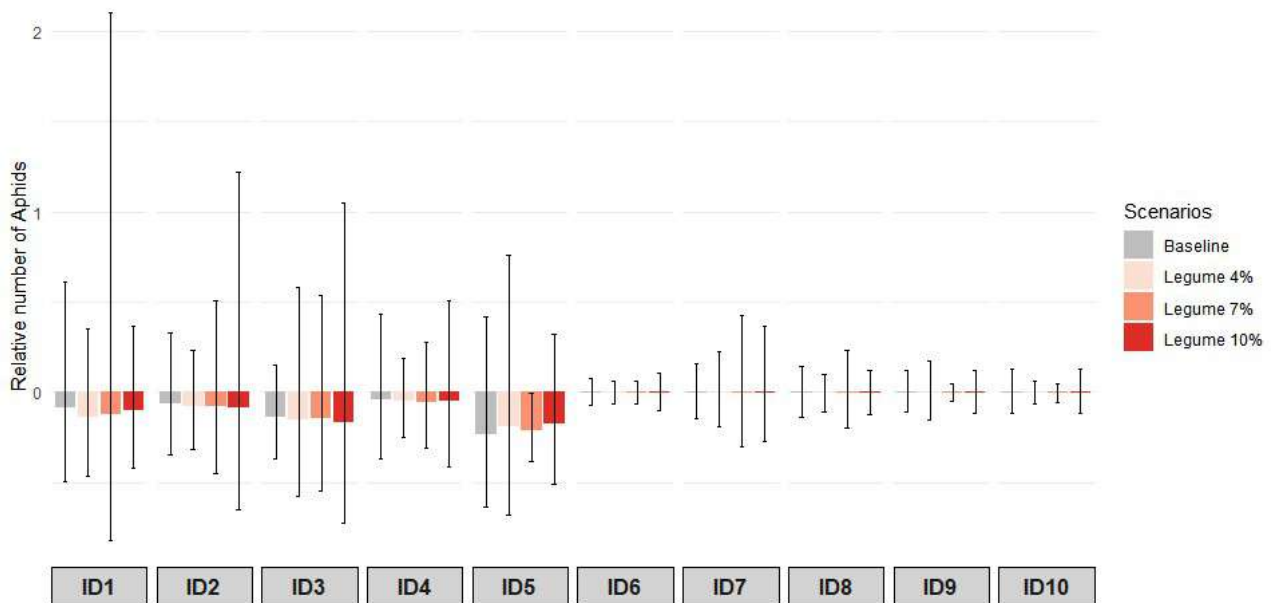


Figure 7.246 Legume scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.14.7 Biopesticides

7.14.7.1 Whole landscape

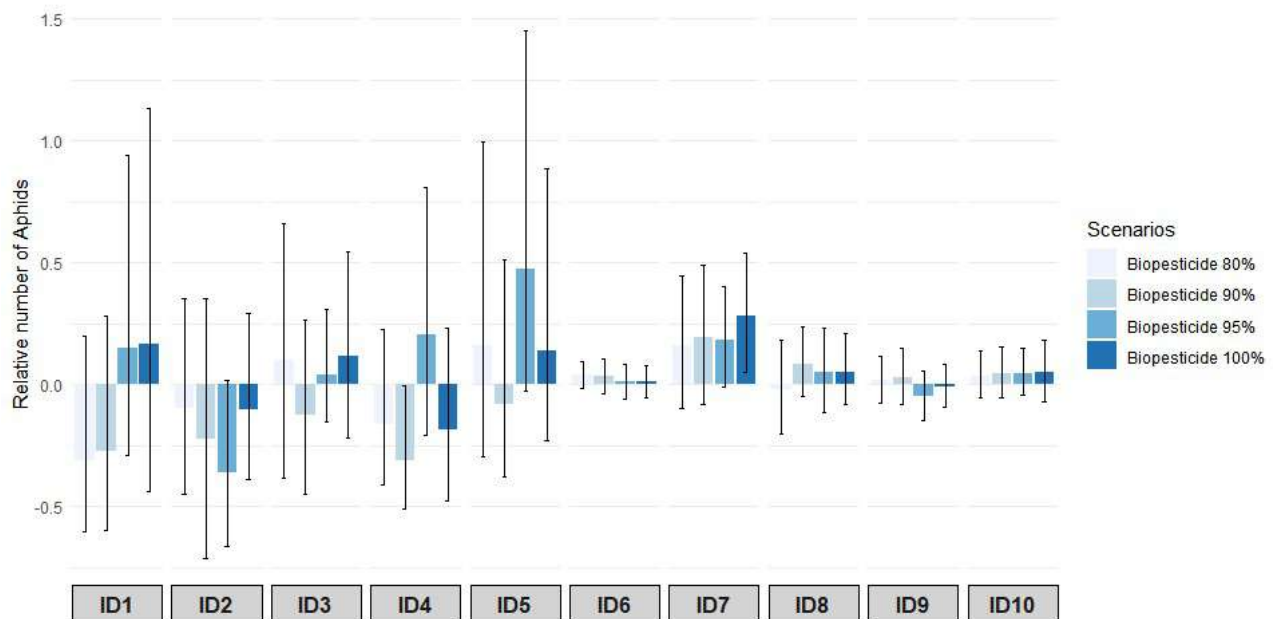


Figure 7.247 Biopesticide scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.14.7.2 In-field

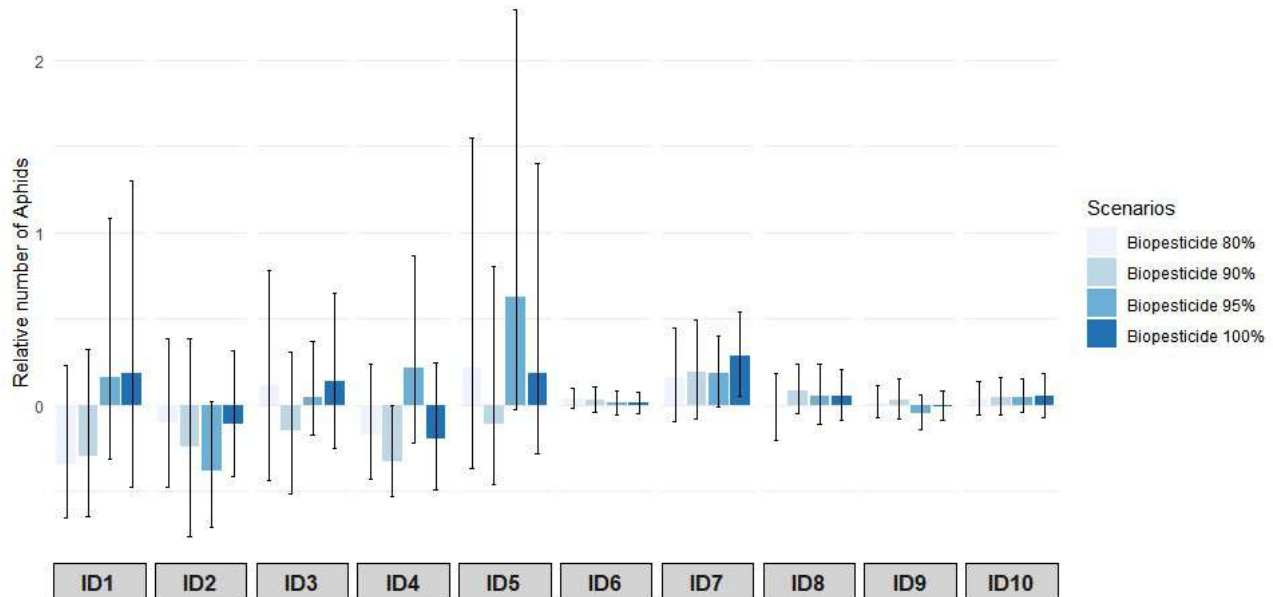


Figure 7.248 Biopesticide scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.14.7.3 In-field relative to landscape

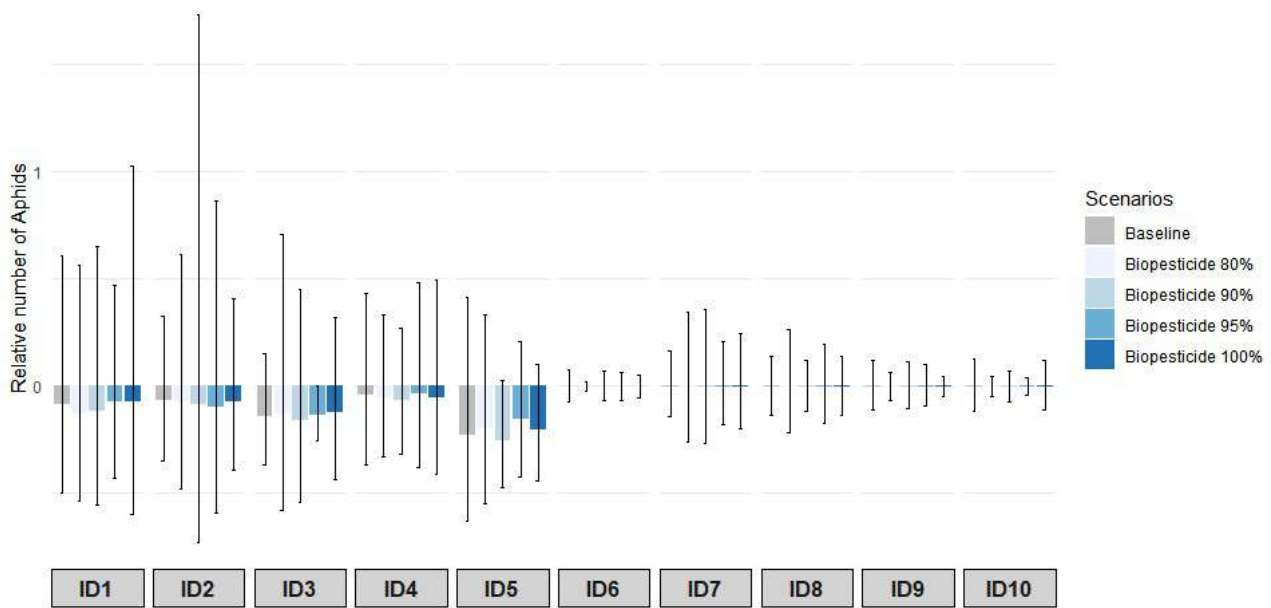


Figure 7.249 Biopesticide scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.15 Denmark

7.15.1 Crop diversification

7.15.1.1 Whole landscape

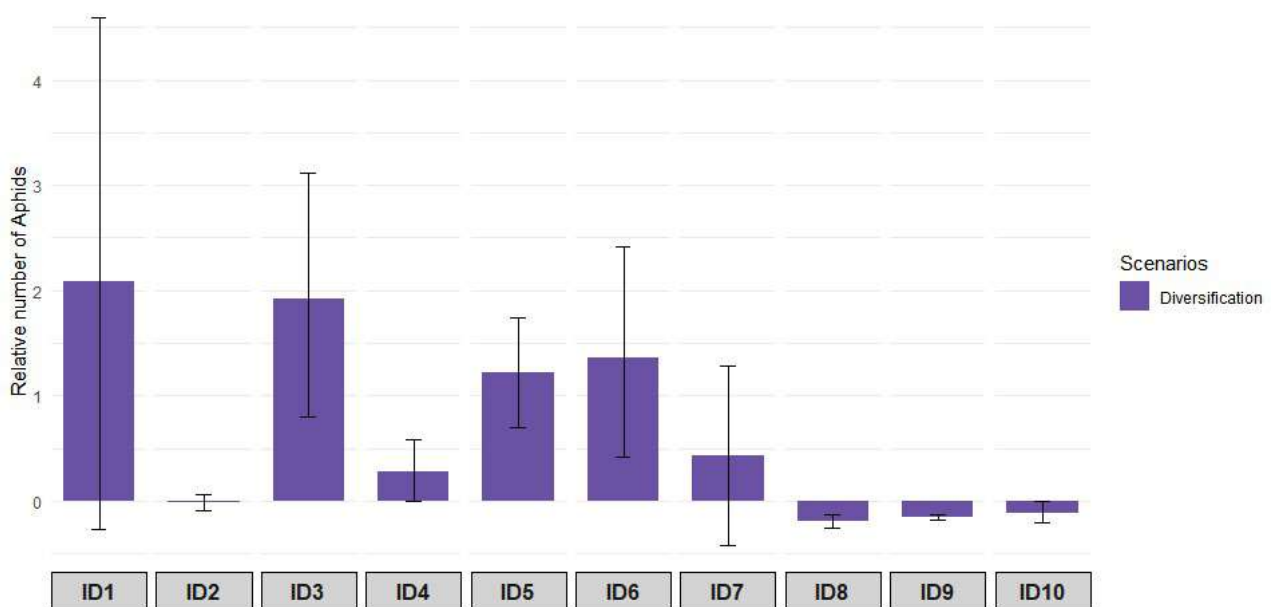


Figure 7.250 Diversification scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.1.2 In-field

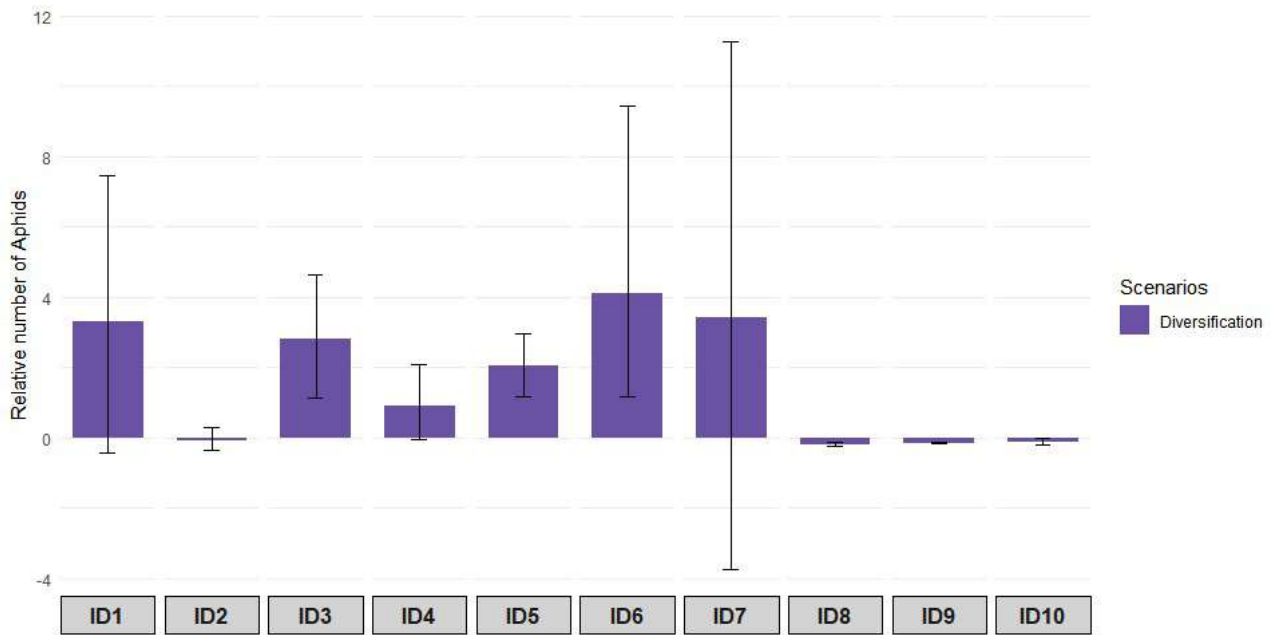


Figure 7.251 Diversification scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.1.3 In-field relative to landscape

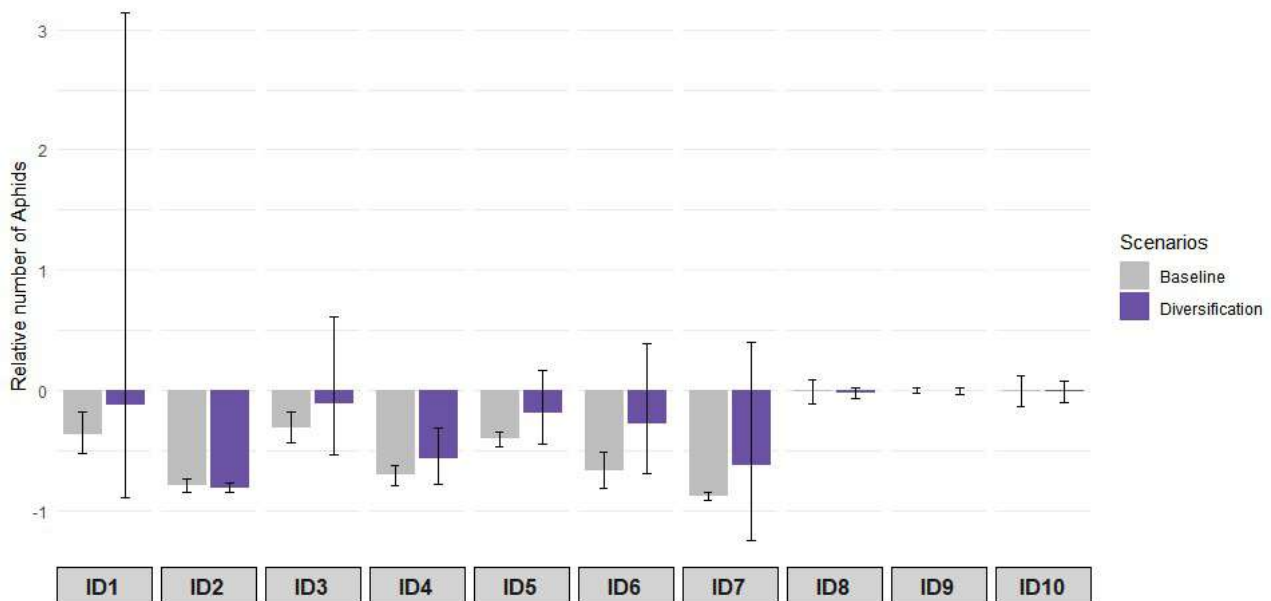


Figure 7.252 Diversification scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.2 Flower field margins

7.15.2.1 Whole landscape

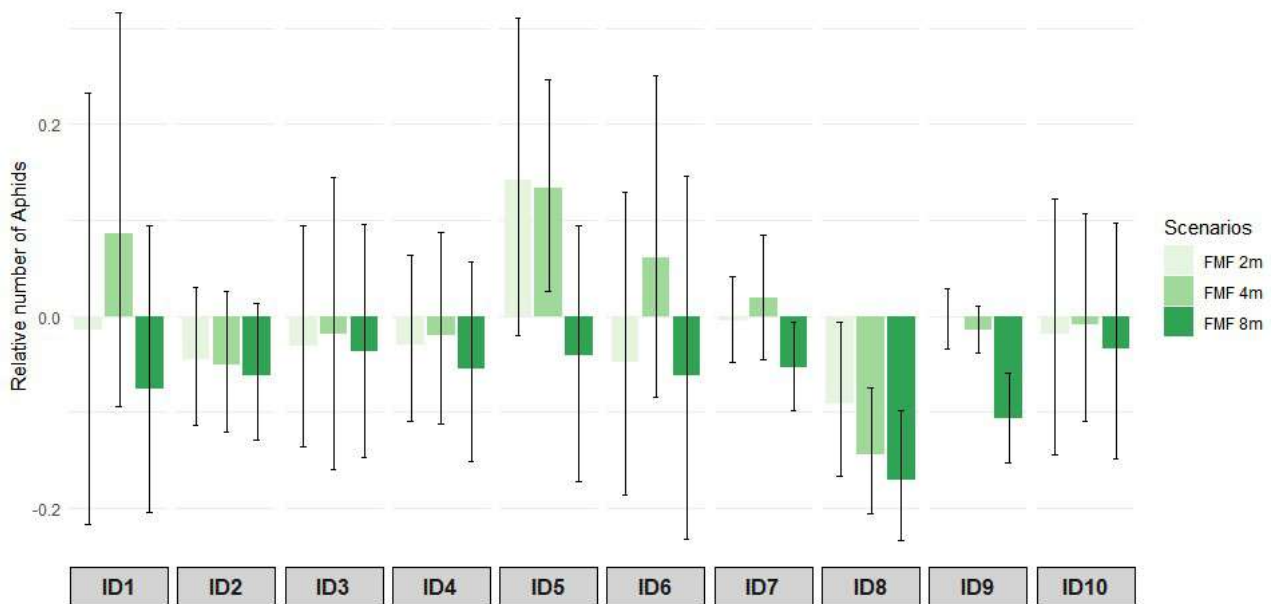


Figure 7.253 Flower field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.2.2 In-field

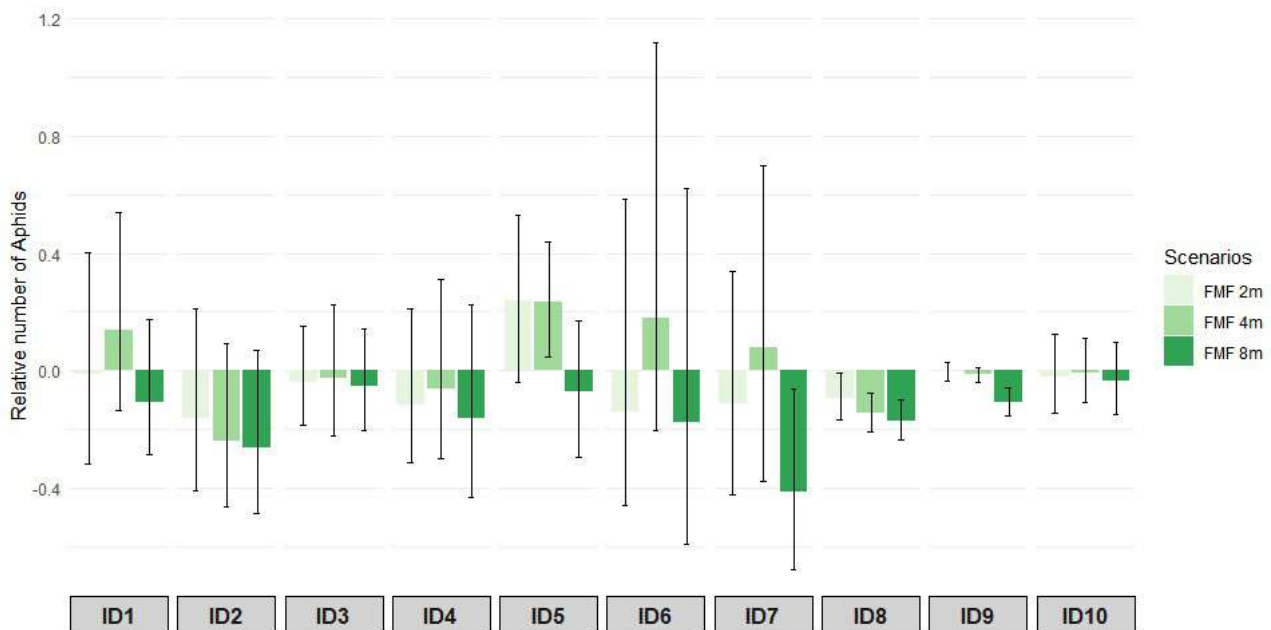


Figure 7.254 Flower field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.2.3 In-field relative to landscape

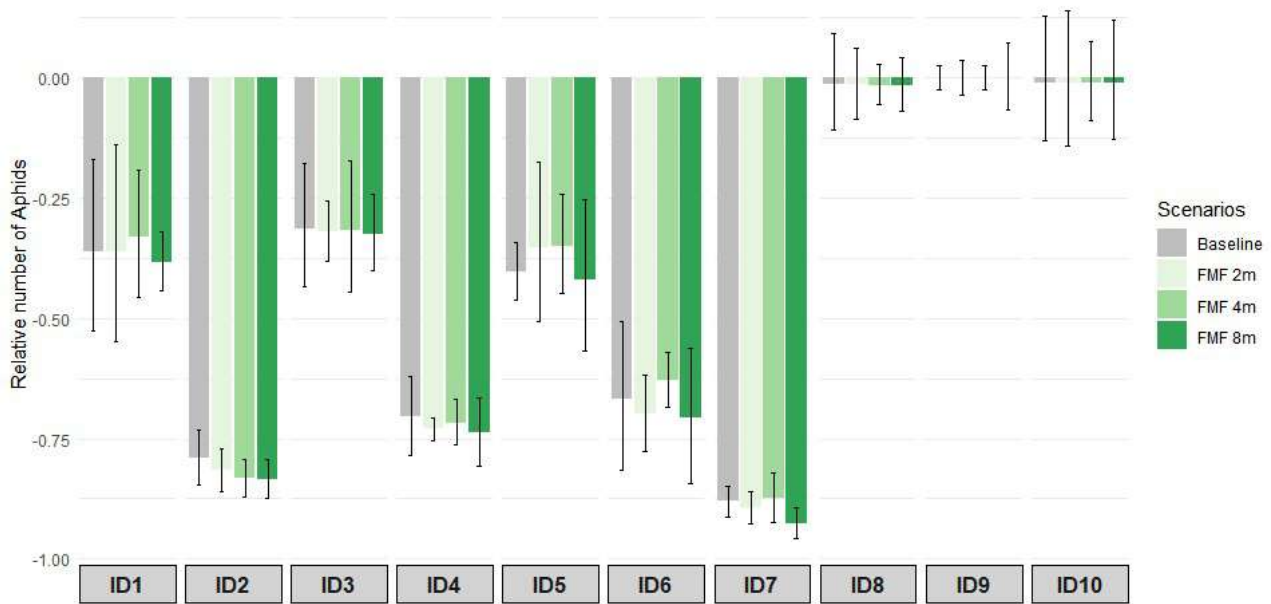


Figure 7.255 Flower field margins scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.3 Grass field margins

7.15.3.1 Whole landscape

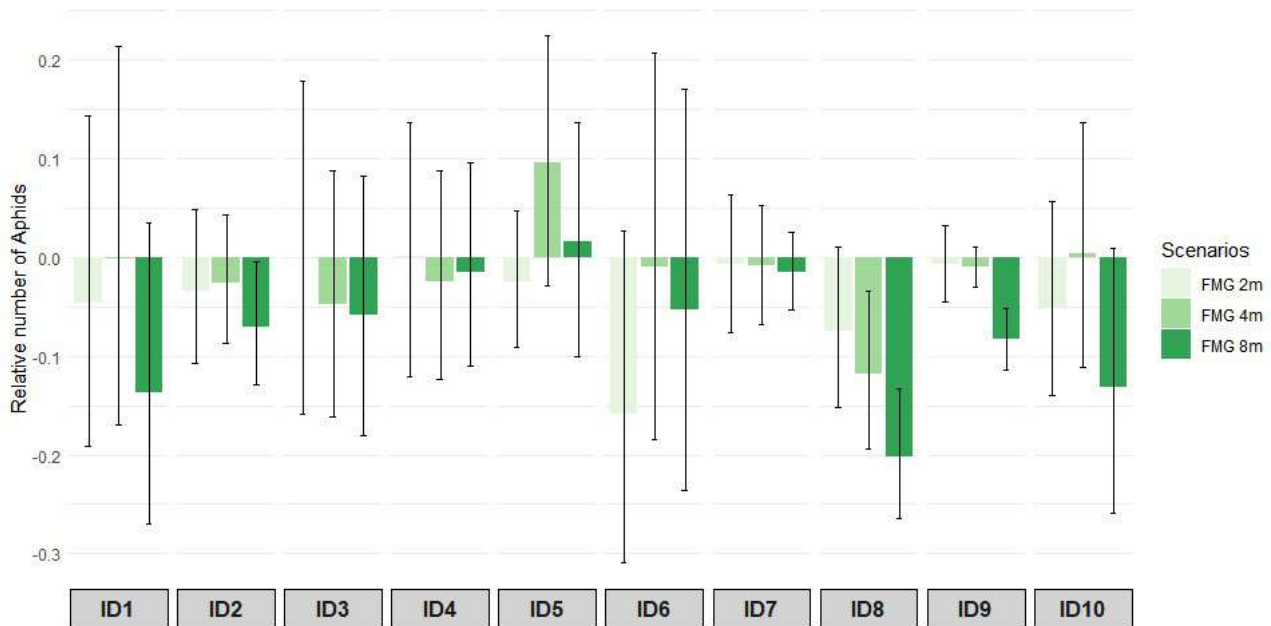


Figure 7.256 Grassy field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.3.2 In-field

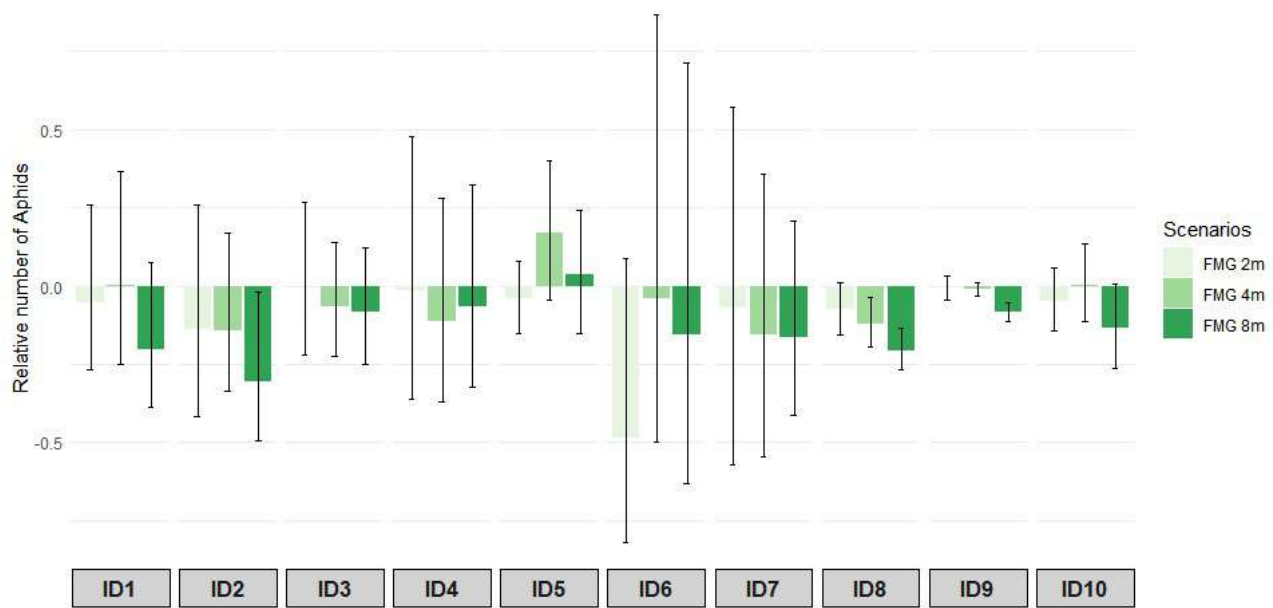


Figure 7.257 Grassy field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.3.3 In-field relative to landscape

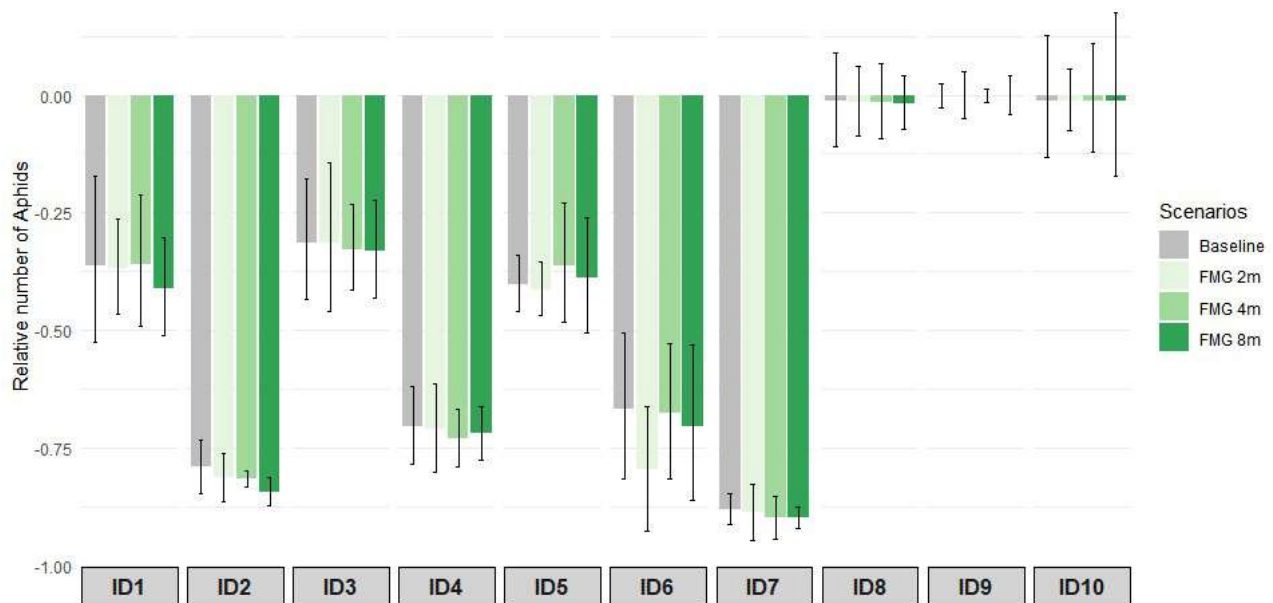


Figure 7.258 Grassy field margins scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.4 Mixed field margins

7.15.4.1 Whole landscape

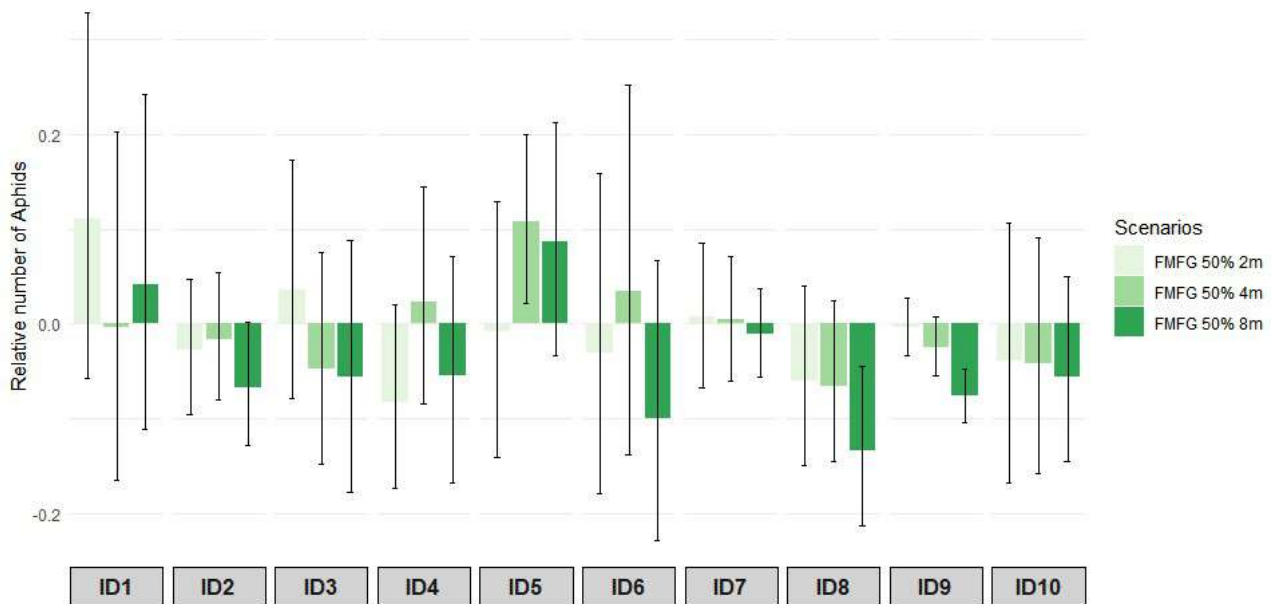


Figure 7.259 Mixed field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.4.2 In-field

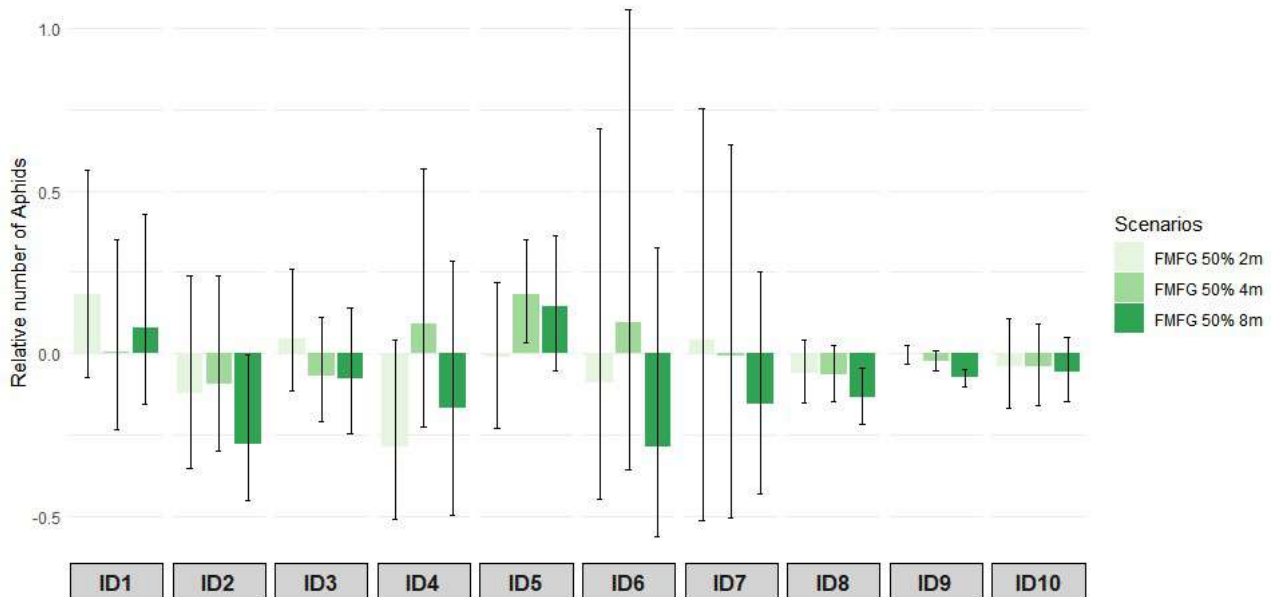


Figure 7.260 Mixed field margins scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.4.3 In-field relative to landscape

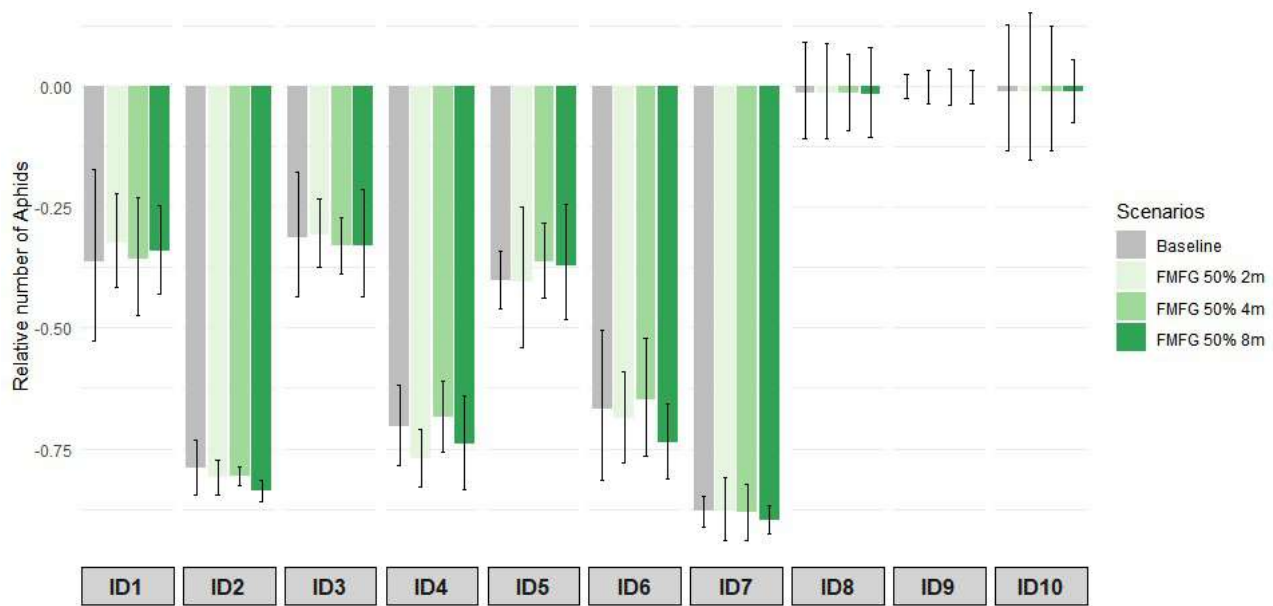


Figure 7.261 Mixed field margins scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.5 Flower, grassy and mixed margins

7.15.5.1 Whole landscape

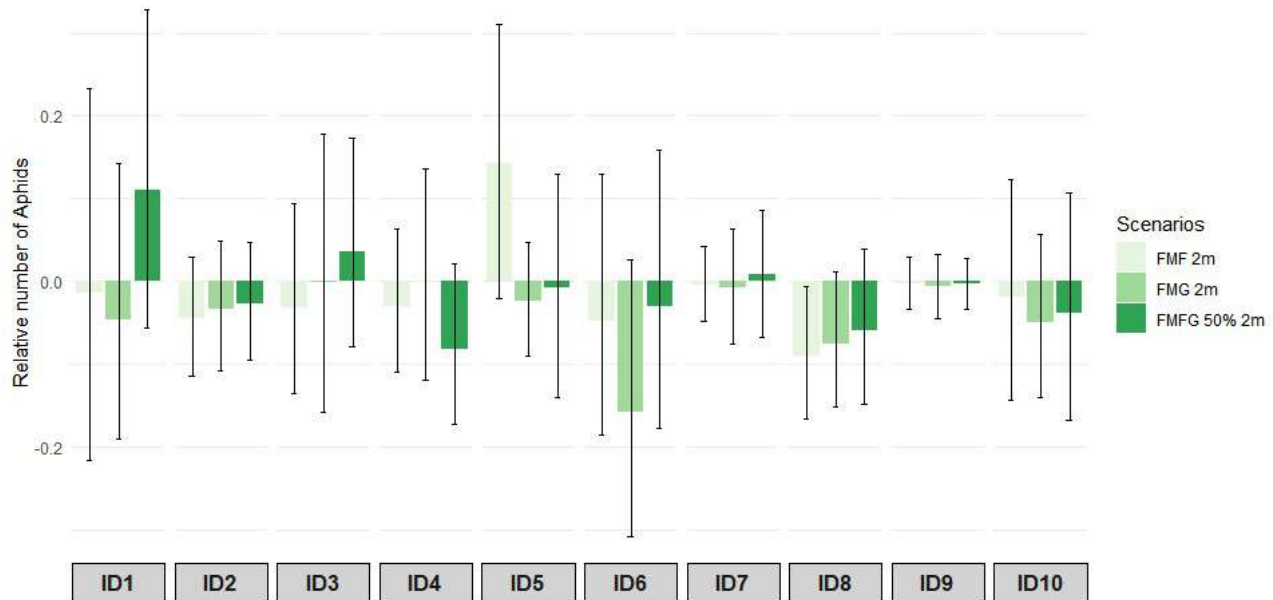


Figure 7.262 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

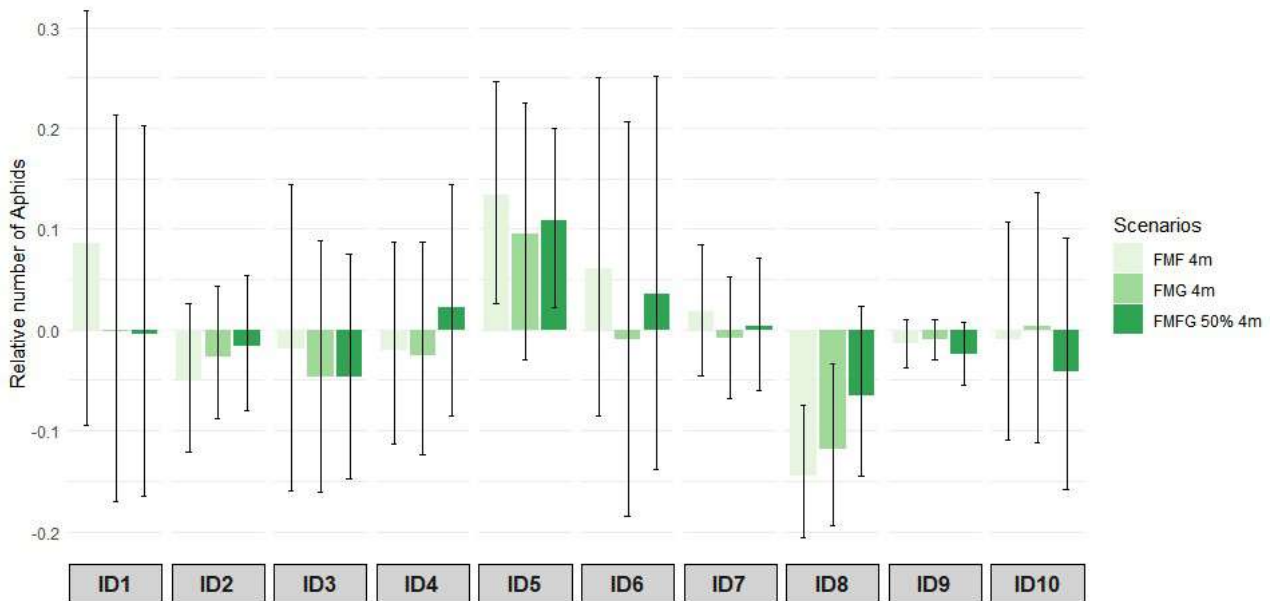


Figure 7.263 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

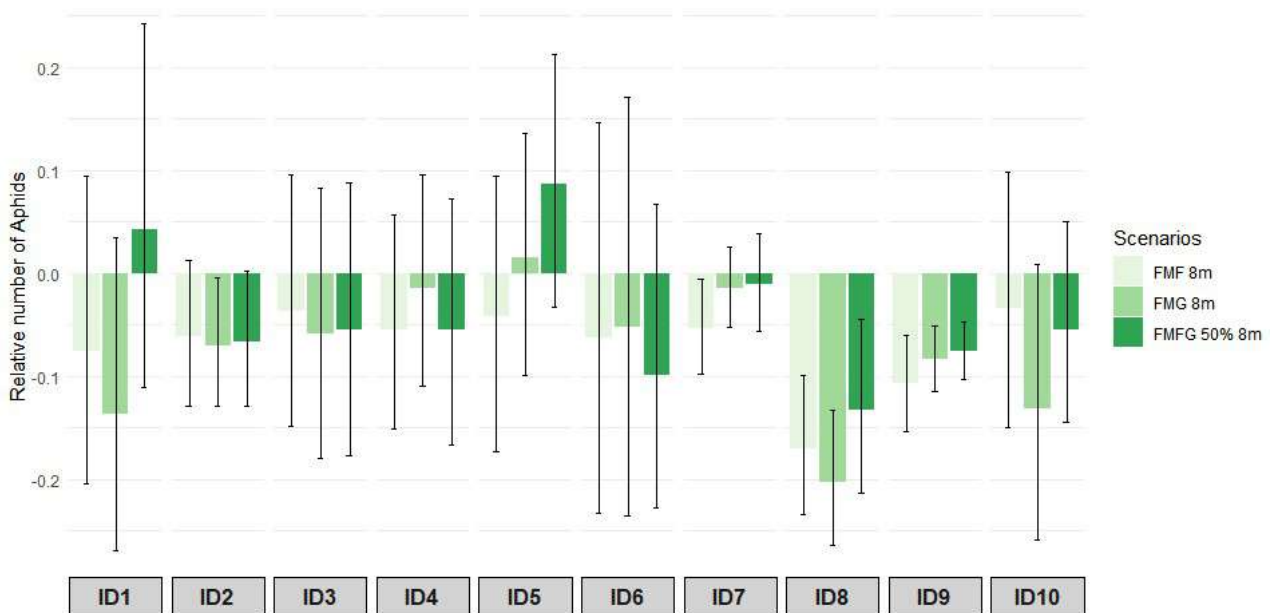


Figure 7.264 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.5.2 In-field

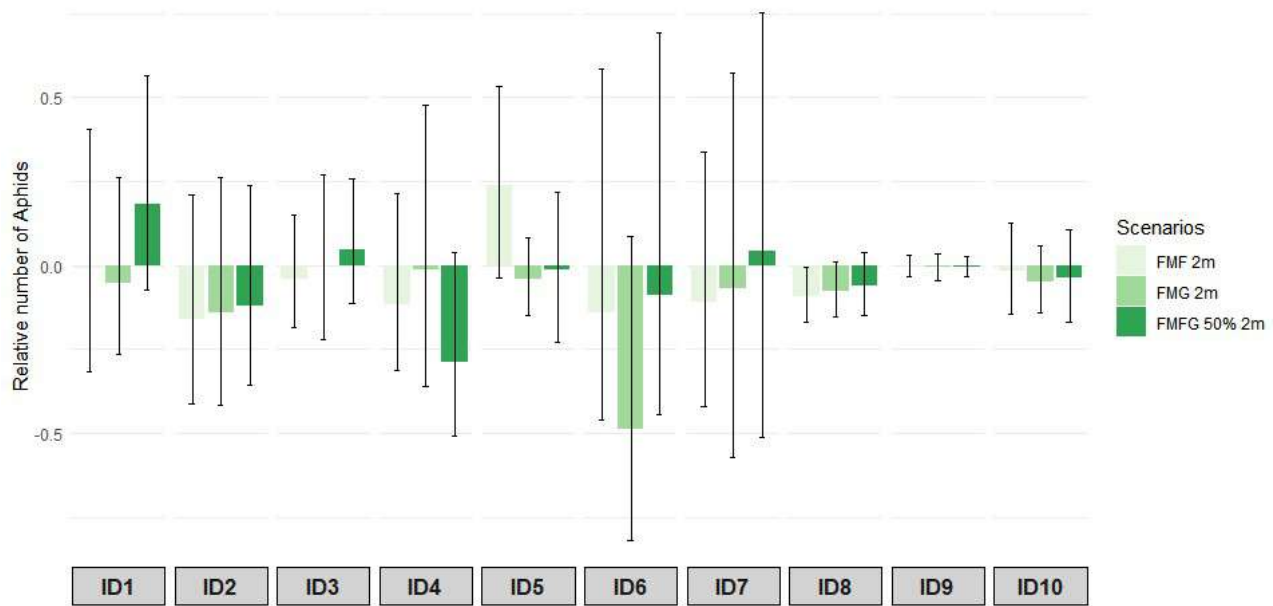


Figure 7.265 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

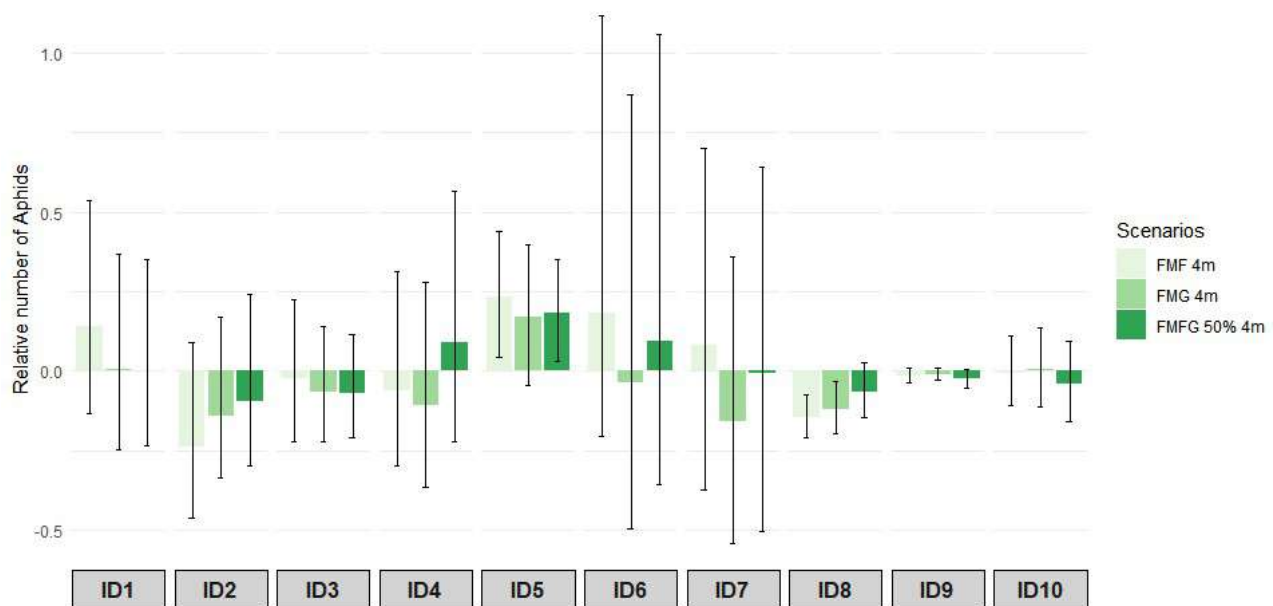


Figure 7.266 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

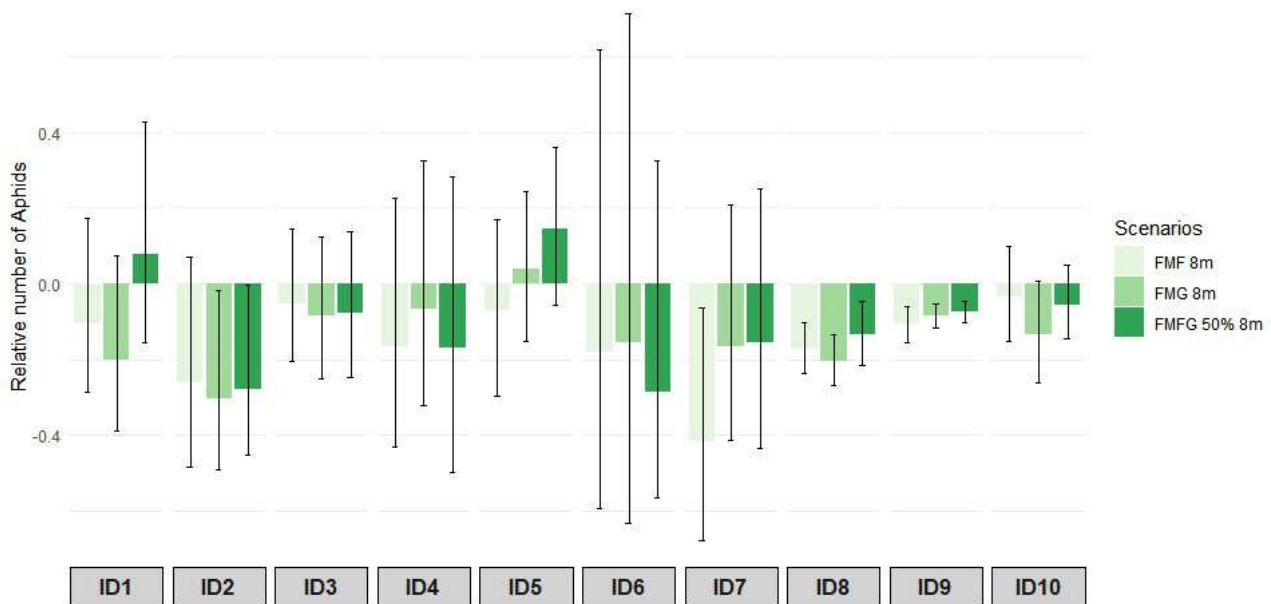


Figure 7.267 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.5.3 In-field relative to landscape

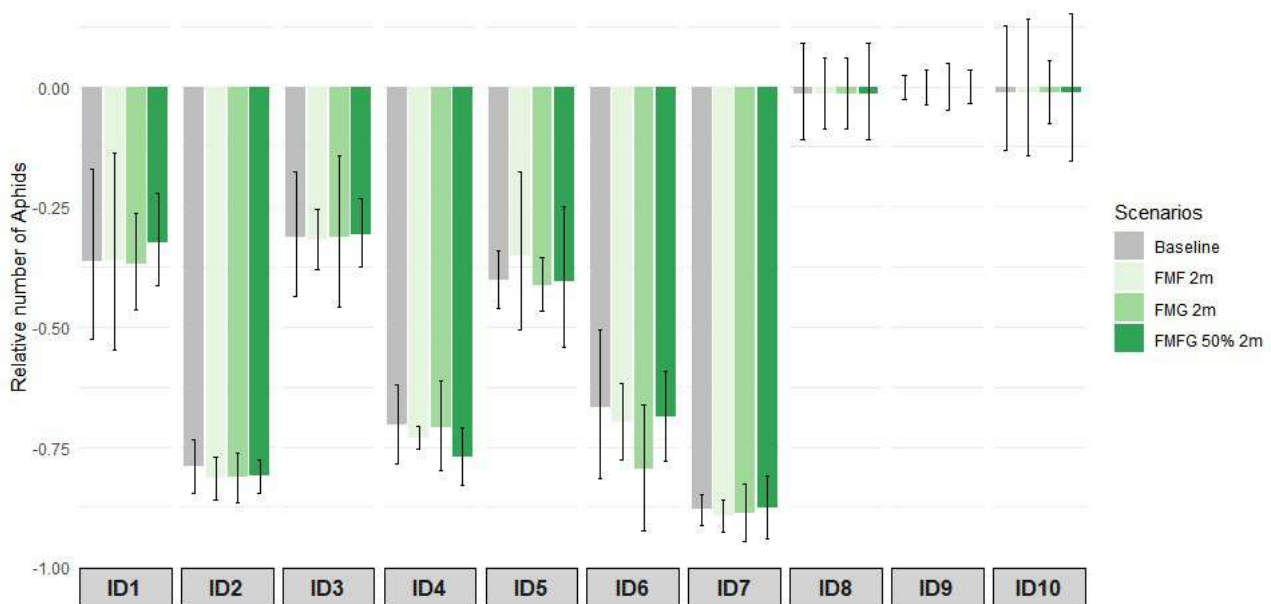


Figure 7.268 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

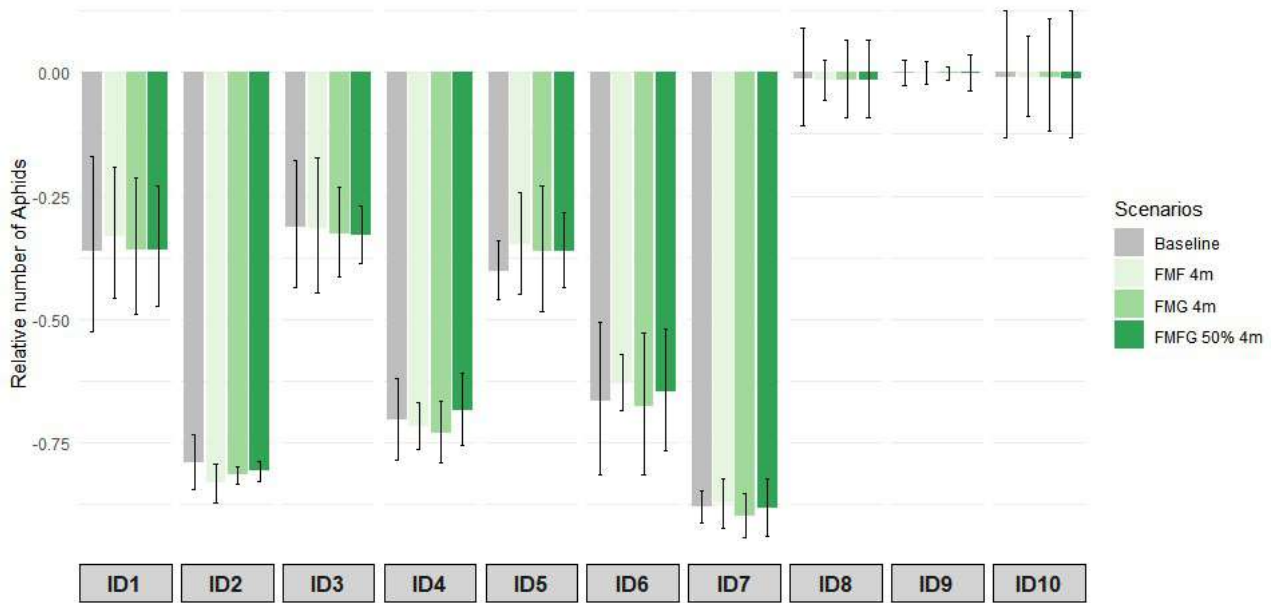


Figure 7.269 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

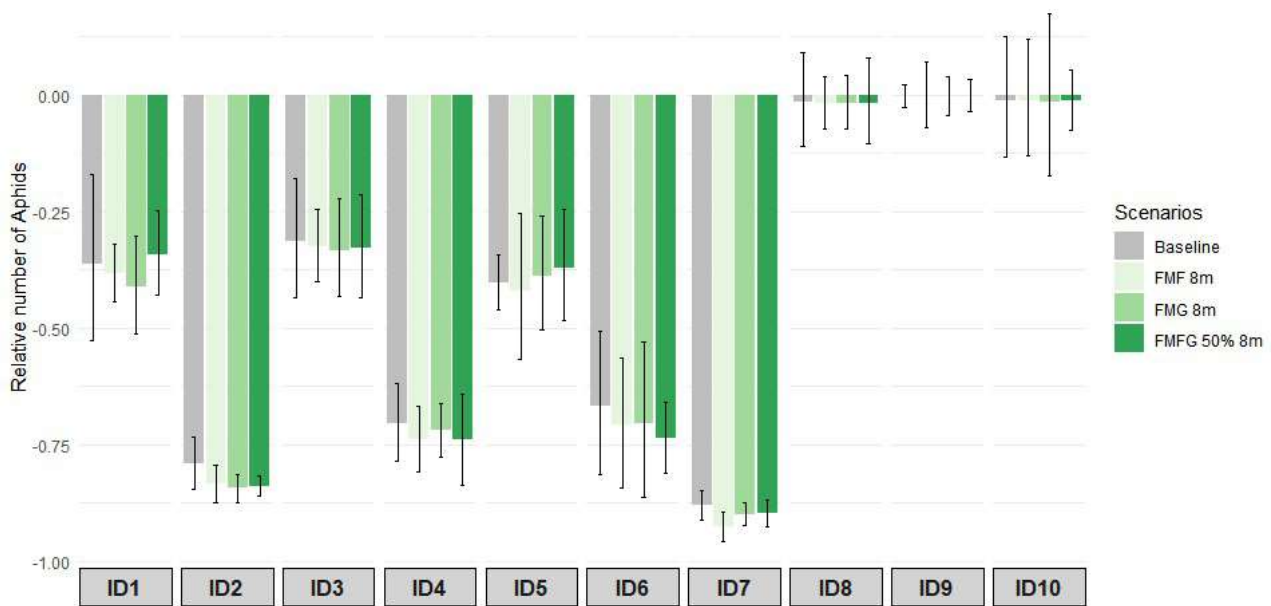


Figure 7.270 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.6 Setaside

7.15.6.1 Whole landscape

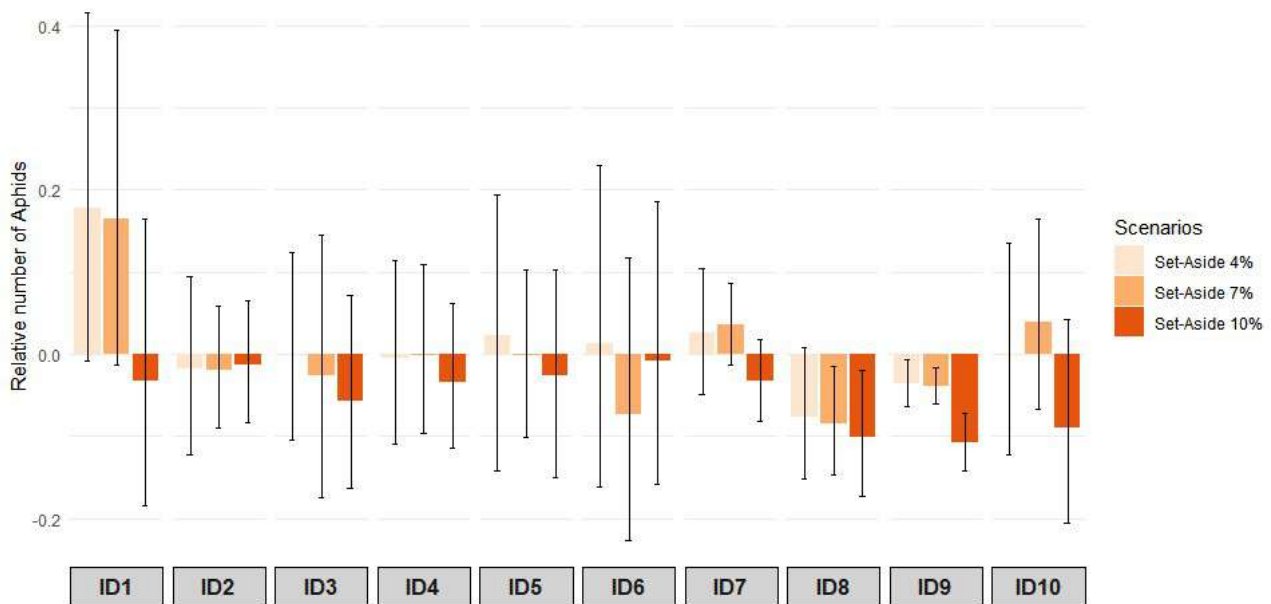


Figure 7.271 Setaside scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.6.2 In-field

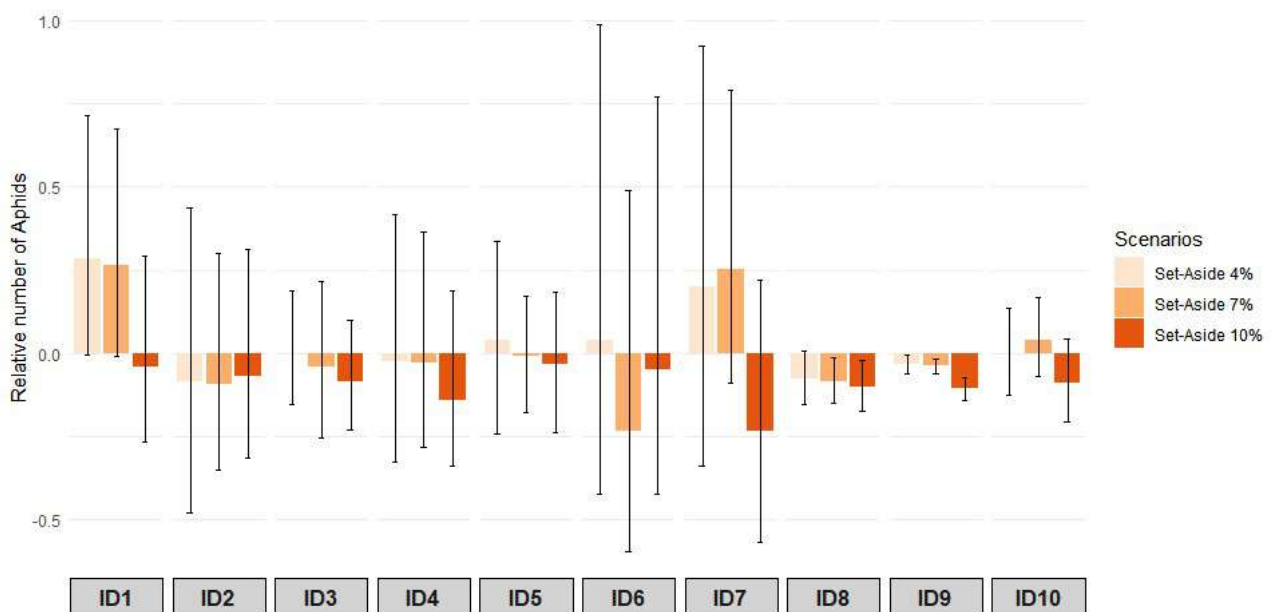


Figure 7.272 Setaside scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.6.3 In-field relative to landscape

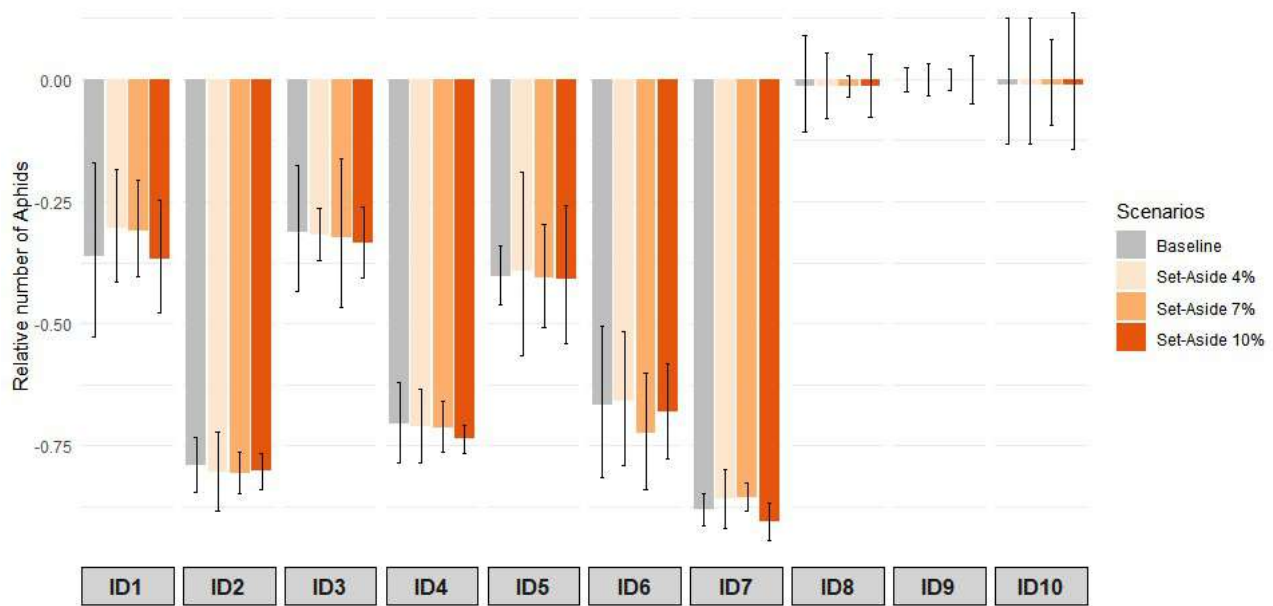


Figure 7.273 Setaside scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.7 Legume

7.15.7.1 Whole landscape

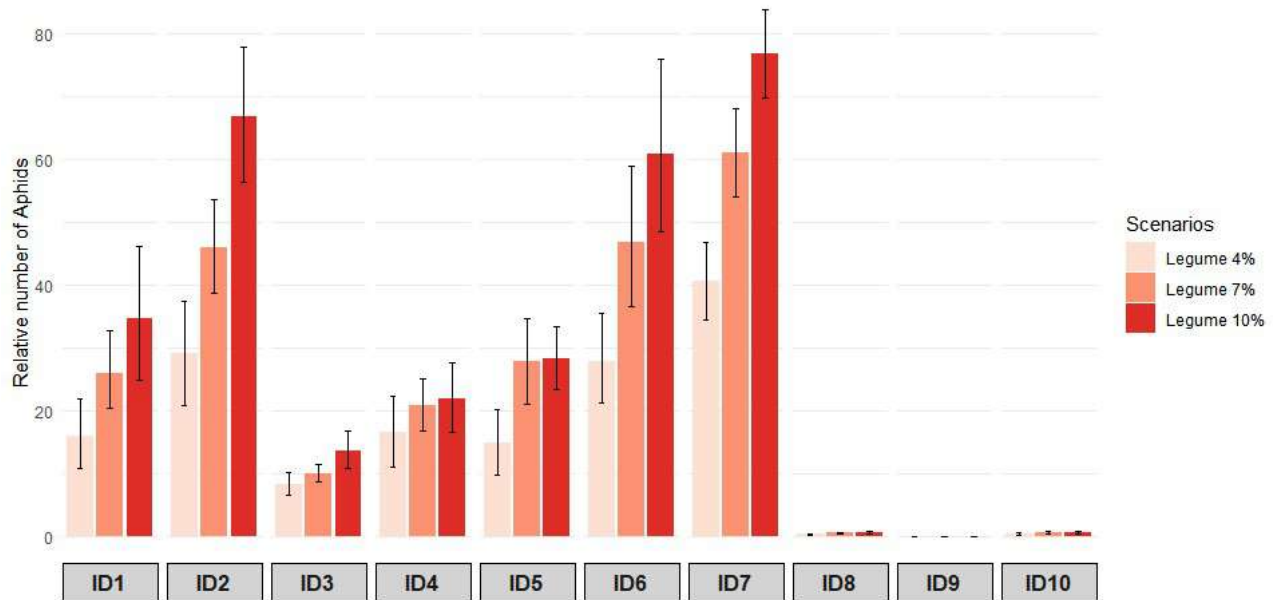


Figure 7.274 Legume scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.7.2 In-field

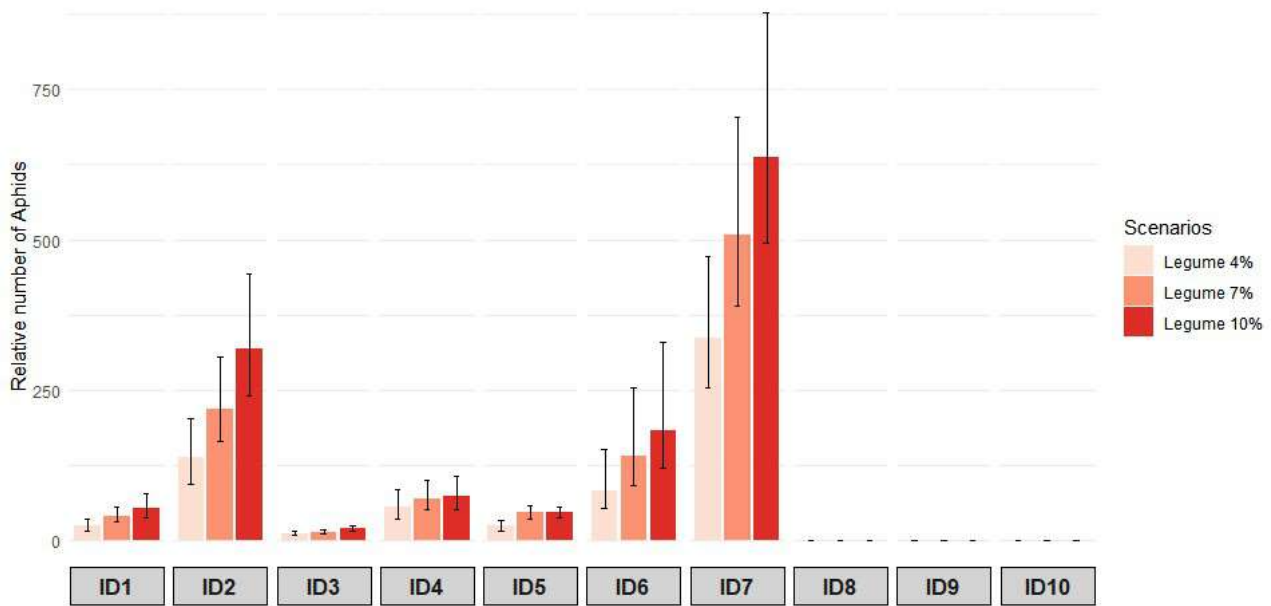


Figure 7.275 Legume scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.7.3 In-field relative to landscape

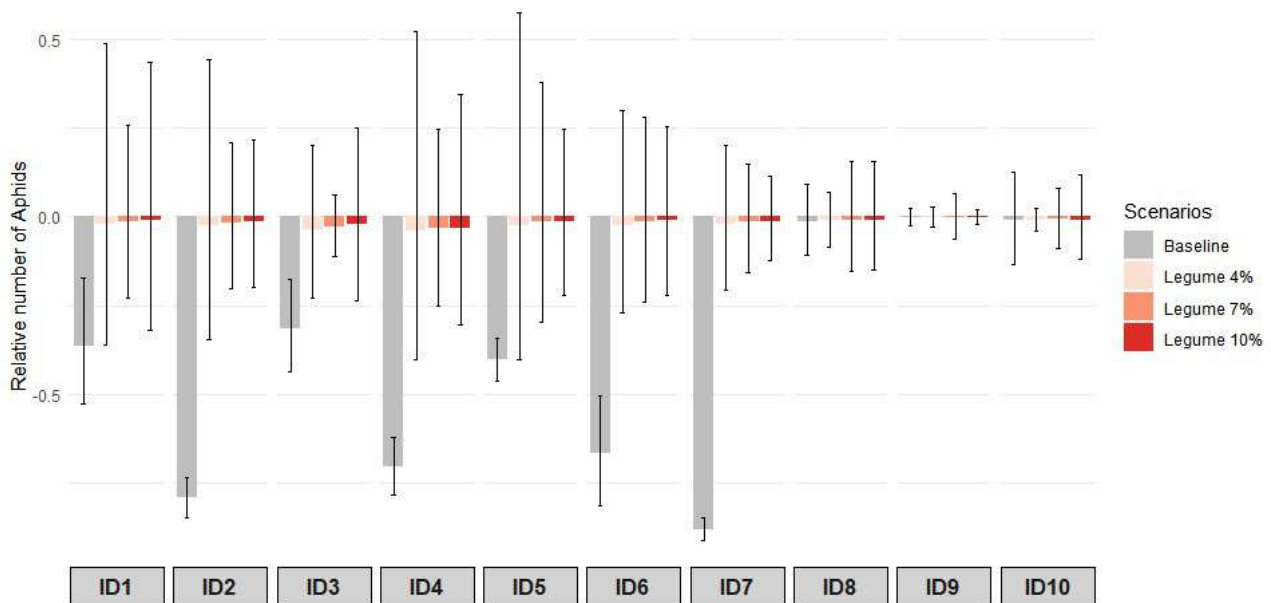


Figure 7.276 Legume scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.15.8 Biopesticides

7.15.8.1 Whole landscape

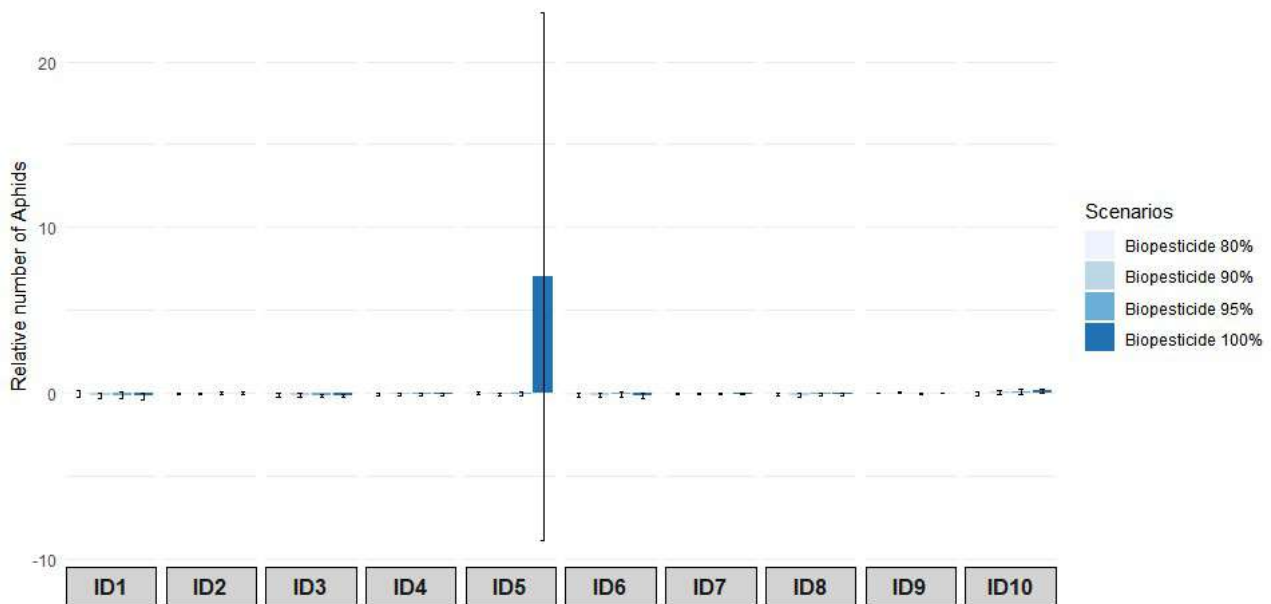


Figure 7.277 Biopesticide scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.15.8.2 In-field

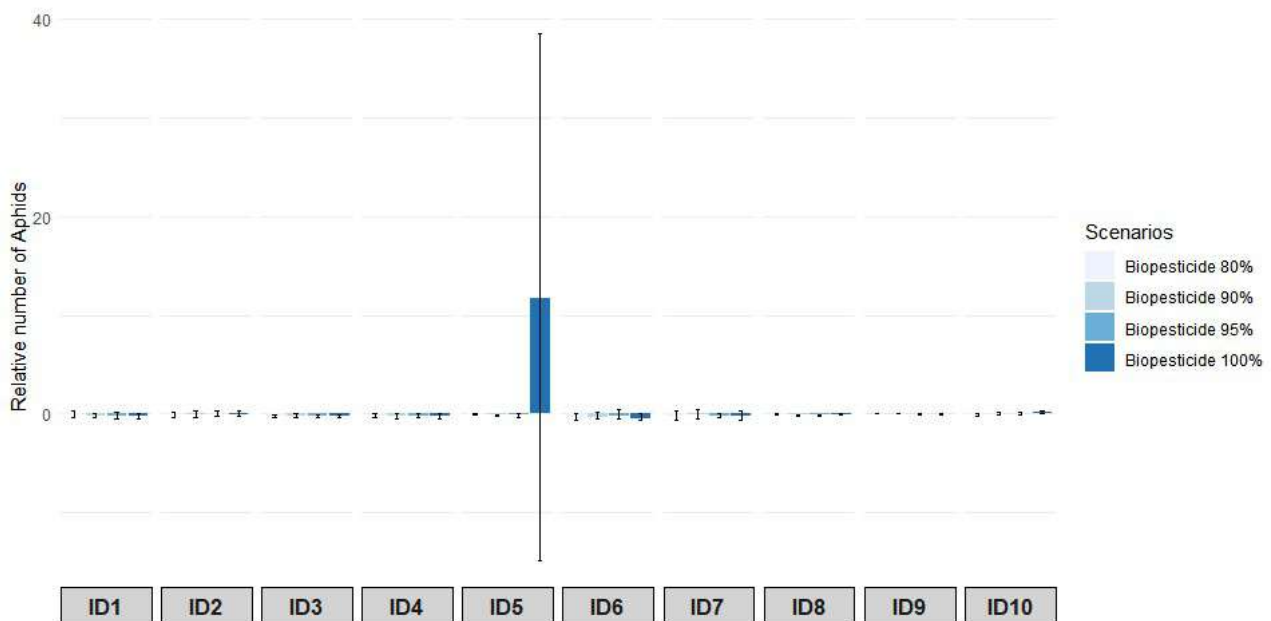


Figure 7.278 Biopesticide scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.15.8.3 In-field relative to landscape

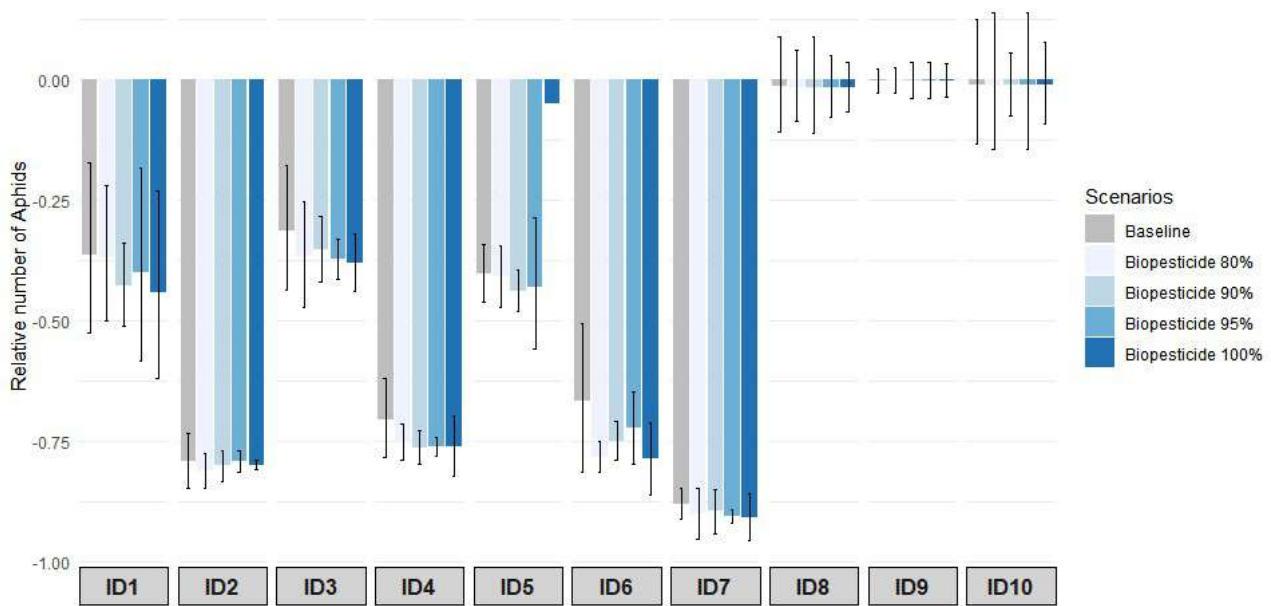


Figure 7.279 Biopesticide scenario with relative change in the number of female Peach potato aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.16 Combined landscapes

7.16.1 Crop diversification

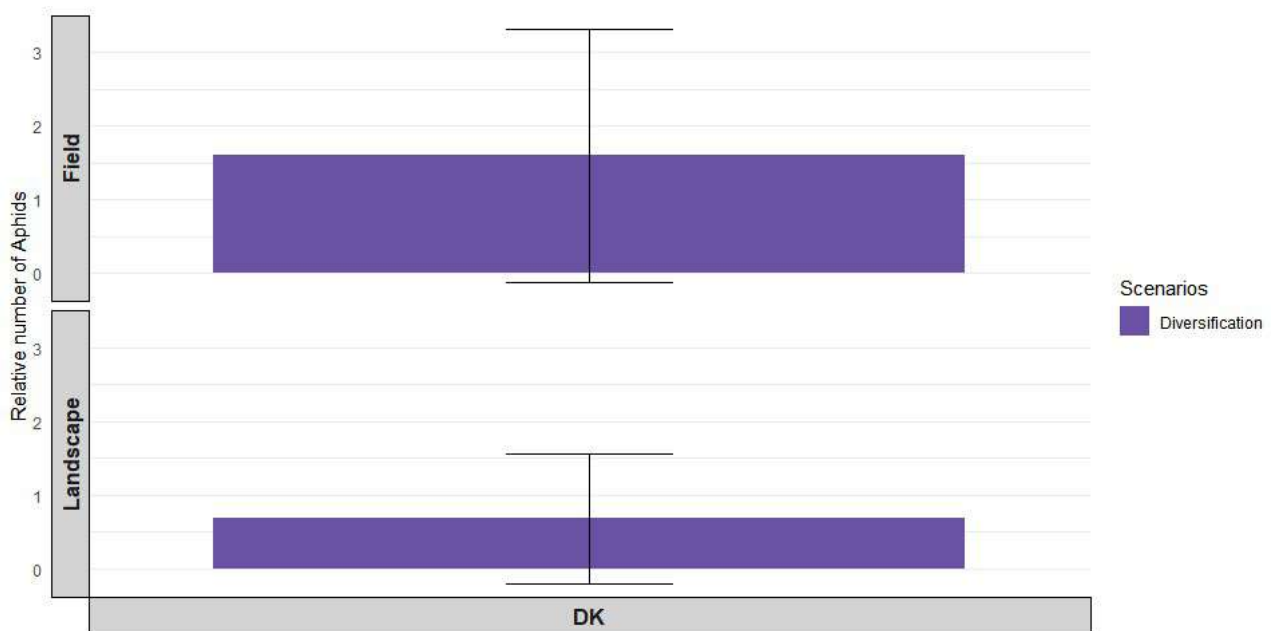


Figure 7.280 Diversification scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Denmark.

7.16.2 Flower field margins

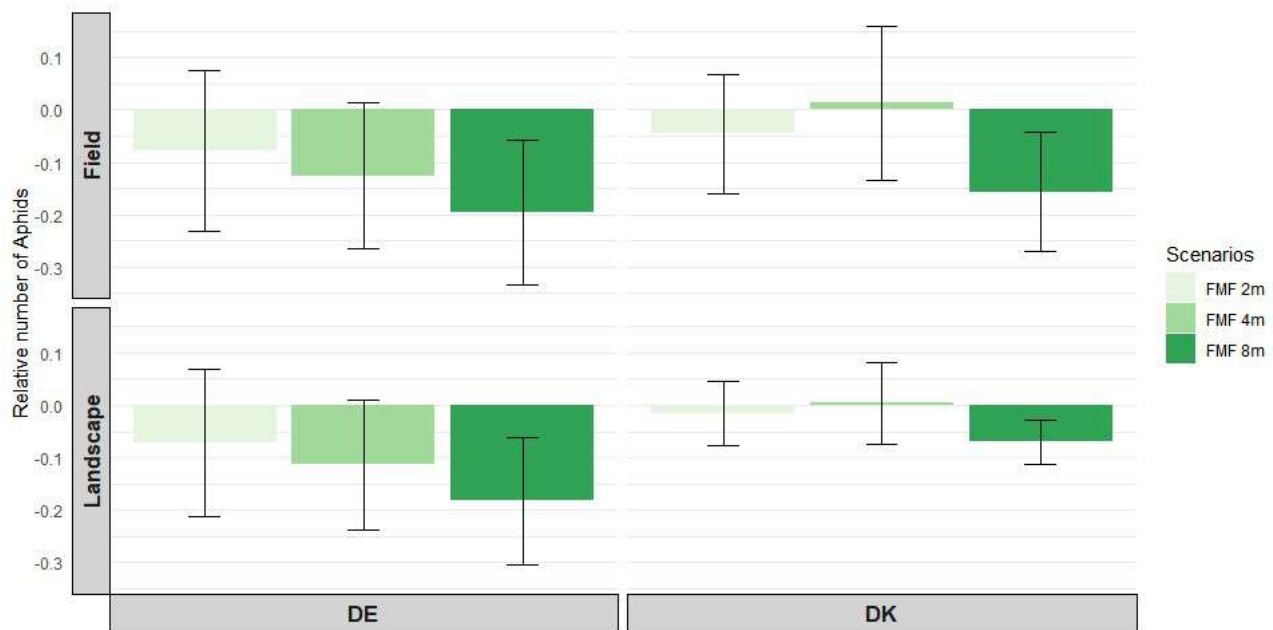


Figure 7.281 Flower field margins with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.3 Grass field margins

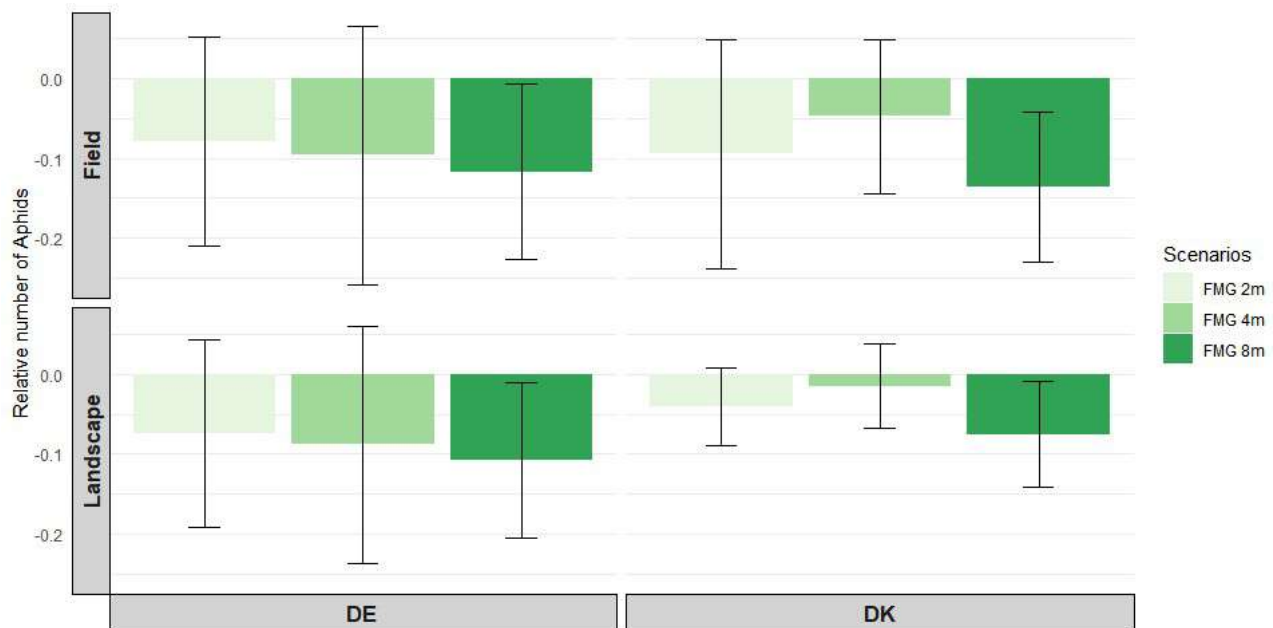


Figure 7.282 Grassy field margins with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.4 Mixed field margins

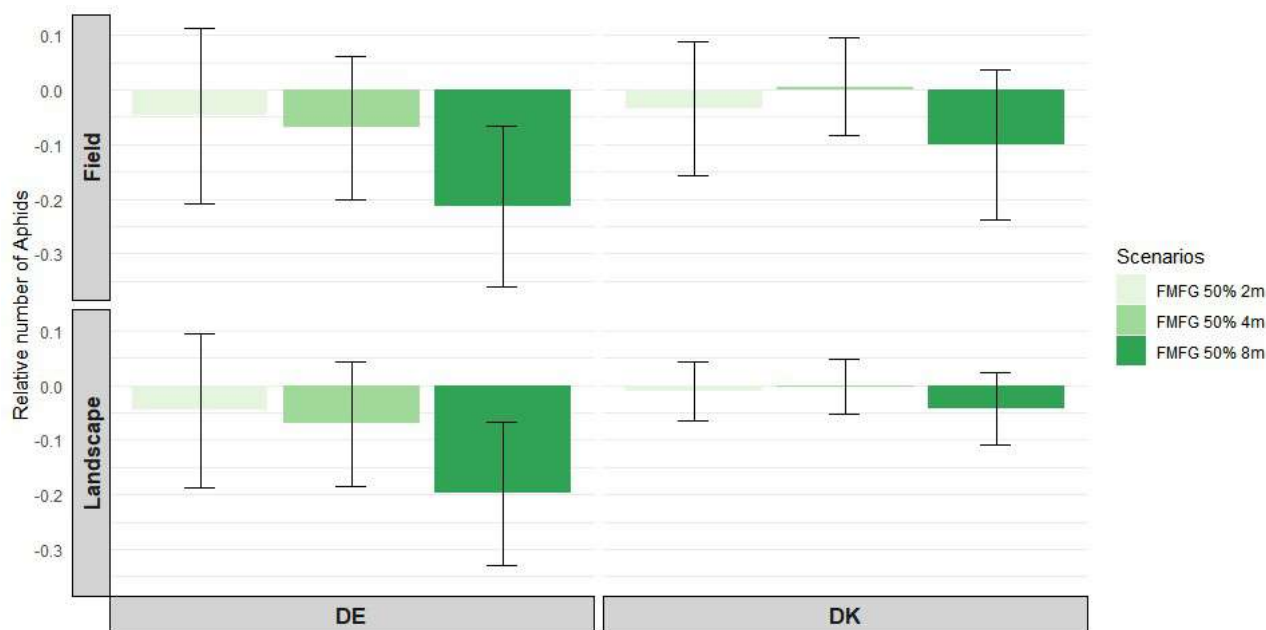


Figure 7.283 Mixed field margins with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.5 Flower, grassy and mixed margins

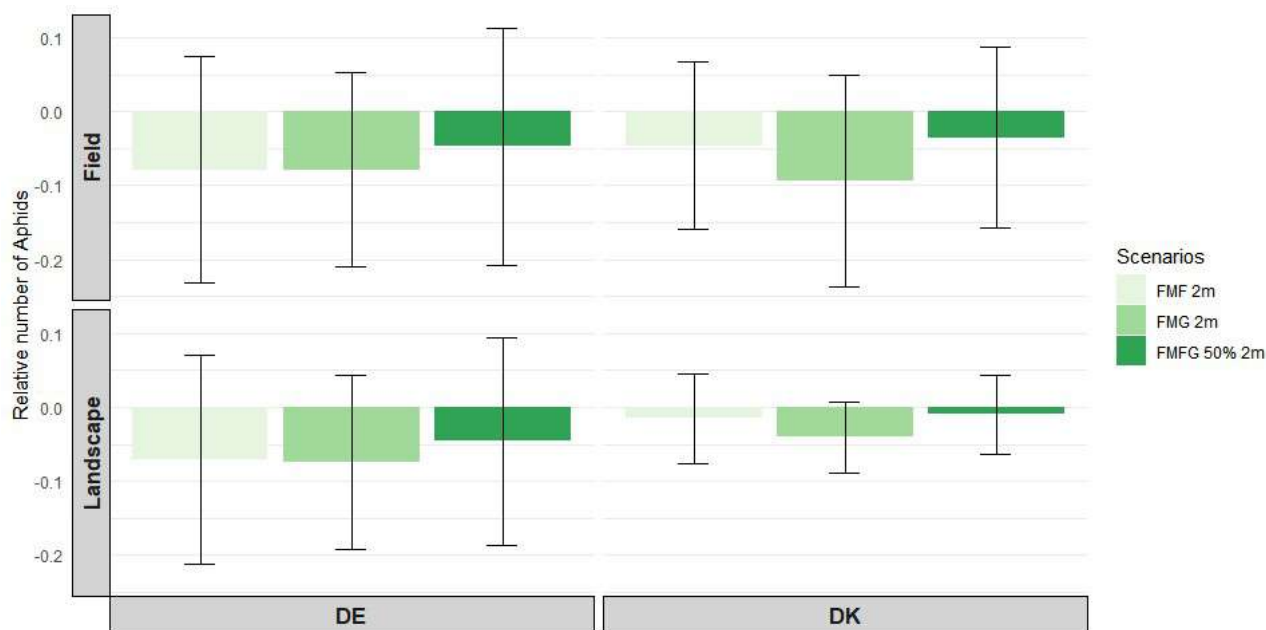


Figure 7.284 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

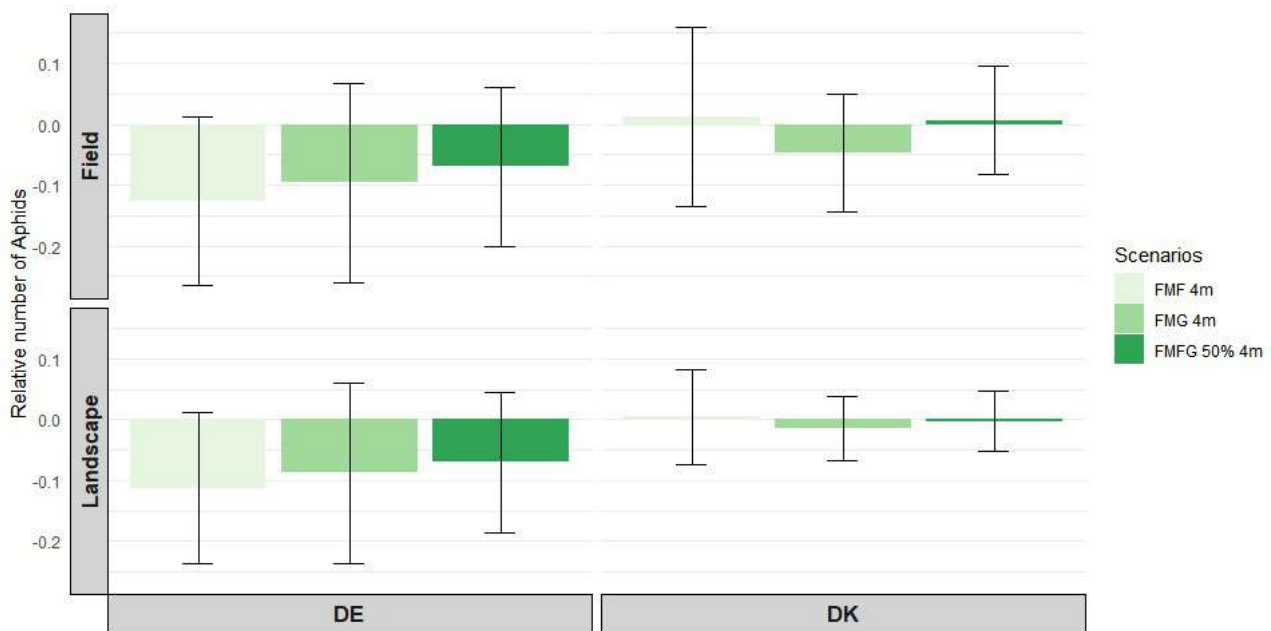


Figure 7.285 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

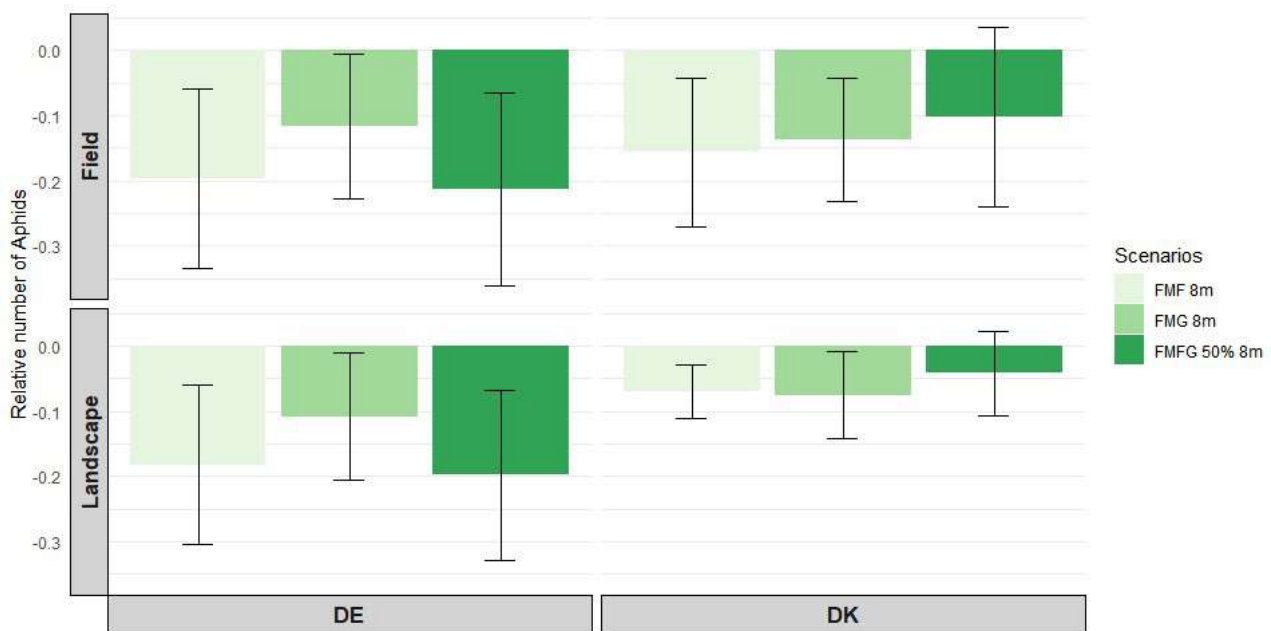


Figure 7.286 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.6 Setaside

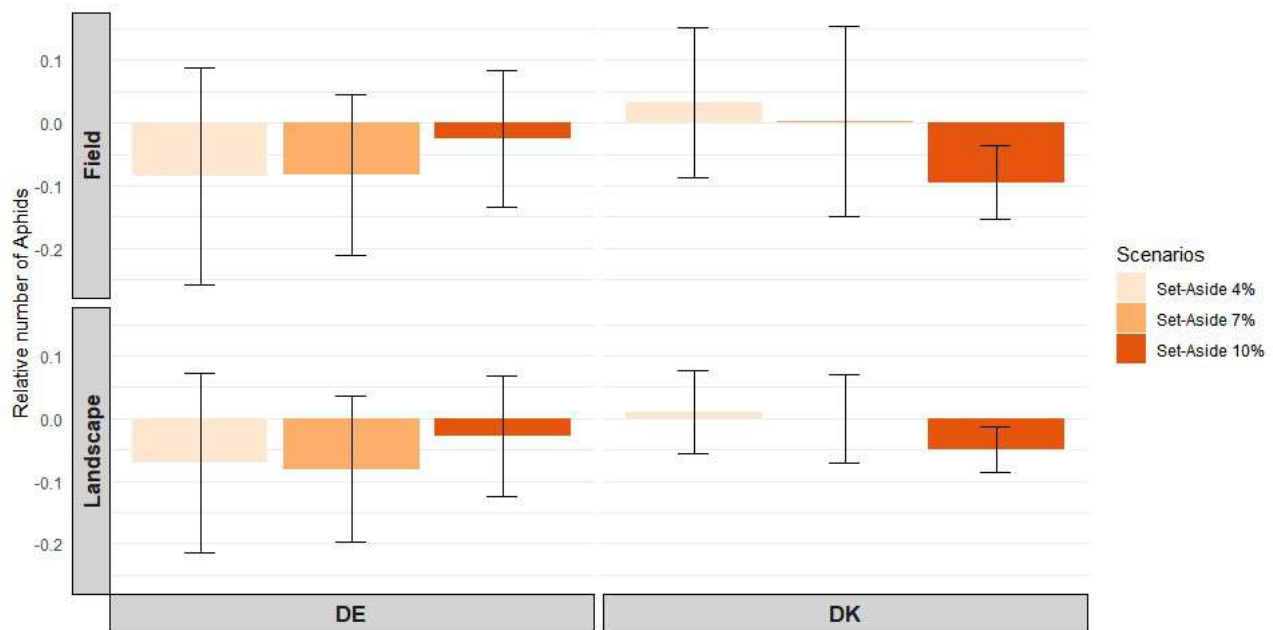


Figure 7.287 Setaside scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.7 Legume

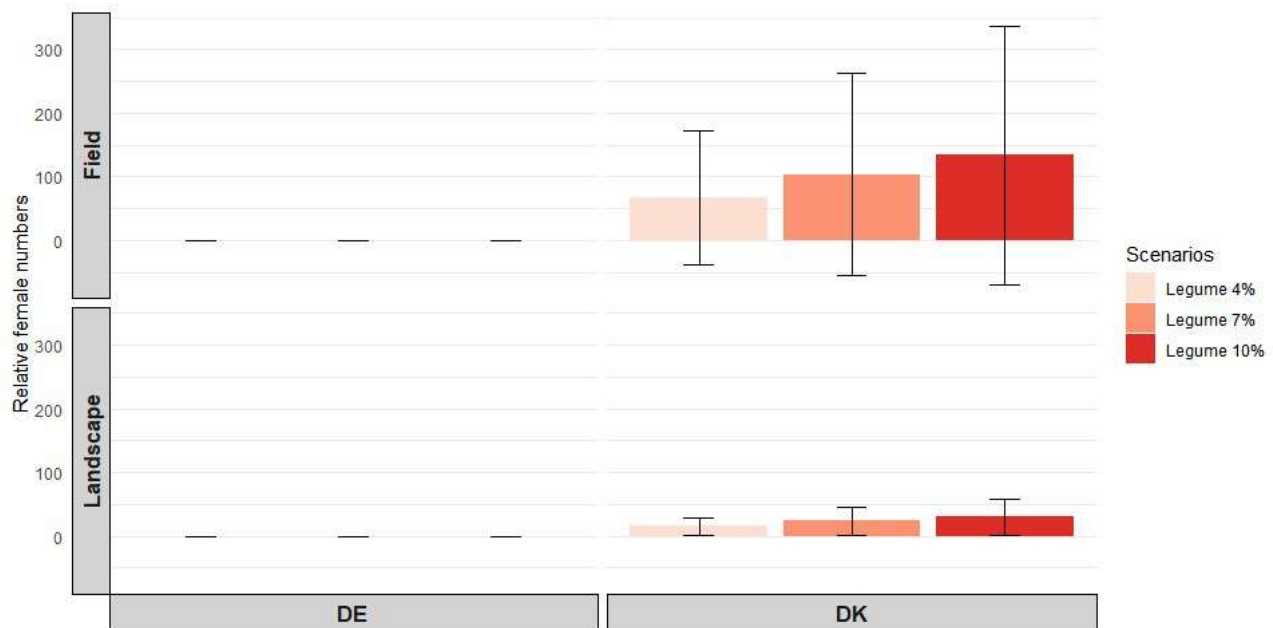


Figure 7.288 Legume scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.8 Biopesticides

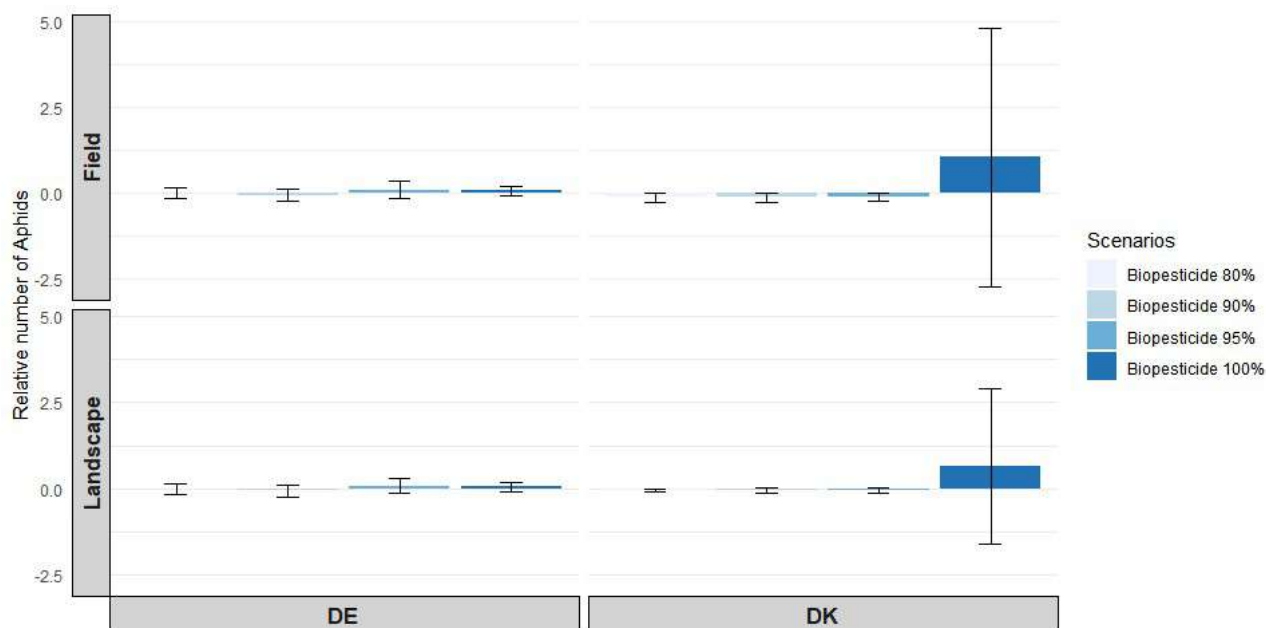


Figure 7.289 Biopesticide scenario with relative change in the number of female Peach potato aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.16.9 Table of relative change compared to baseline scenarios

Table 7.4 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for Peach potato aphids. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scale	Scenario	DK	DE
Field	Diversification	160% (SD 172%)	NA
Landscape	Diversification	68% (SD 89%)	NA
Field	FMF 2m	-5% (SD 11%)	-8% (SD 15%)
Field	FMF 4m	1% (SD 15%)	-13% (SD 14%)
Field	FMF 8m	-16% (SD 11%)	-20% (SD 14%)
Landscape	FMF 2m	-1% (SD 6%)	-7% (SD 14%)
Landscape	FMF 4m	0% (SD 8%)	-11% (SD 12%)
Landscape	FMF 8m	-7% (SD 4%)	-18% (SD 12%)
Field	FMG 2m	-9% (SD 14%)	-8% (SD 13%)
Field	FMG 4m	-5% (SD 10%)	-10% (SD 16%)
Field	FMG 8m	-14% (SD 9%)	-12% (SD 11%)
Landscape	FMG 2m	-4% (SD 5%)	-7% (SD 12%)

Scale	Scenario	DK	DE
Landscape	FMG 4m	-1% (SD 5%)	-9% (SD 15%)
Landscape	FMG 8m	-8% (SD 7%)	-11% (SD 10%)
Field	FMFG 50% 2m	-3% (SD 12%)	-5% (SD 16%)
Field	FMFG 50% 4m	1% (SD 9%)	-7% (SD 13%)
Field	FMFG 50% 8m	-10% (SD 14%)	-21% (SD 15%)
Landscape	FMFG 50% 2m	-1% (SD 5%)	-5% (SD 14%)
Landscape	FMFG 50% 4m	-0% (SD 5%)	-7% (SD 11%)
Landscape	FMFG 50% 8m	-4% (SD 7%)	-20% (SD 13%)
Field	Set-Aside 4%	3% (SD 12%)	-9% (SD 17%)
Field	Set-Aside 7%	0% (SD 15%)	-8% (SD 13%)
Field	Set-Aside 10%	-10% (SD 6%)	-3% (SD 11%)
Landscape	Set-Aside 4%	1% (SD 7%)	-7% (SD 14%)
Landscape	Set-Aside 7%	-0% (SD 7%)	-8% (SD 12%)
Landscape	Set-Aside 10%	-5% (SD 4%)	-3% (SD 10%)
Field	Legume 4%	6770% (SD 10465%)	-4% (SD 19%)
Field	Legume 7%	10393% (SD 15850%)	-7% (SD 14%)
Field	Legume 10%	13356% (SD 20396%)	-3% (SD 19%)
Landscape	Legume 4%	1534% (SD 1380%)	-4% (SD 16%)
Landscape	Legume 7%	2389% (SD 2178%)	-6% (SD 13%)
Landscape	Legume 10%	3038% (SD 2882%)	-4% (SD 16%)
Field	Biopesticide 80%	-13% (SD 14%)	-1% (SD 16%)
Field	Biopesticide 90%	-13% (SD 13%)	-7% (SD 18%)
Field	Biopesticide 95%	-12% (SD 12%)	9% (SD 25%)
Field	Biopesticide 100%	103% (SD 378%)	6% (SD 14%)
Landscape	Biopesticide 80%	-5% (SD 5%)	-1% (SD 15%)
Landscape	Biopesticide 90%	-6% (SD 7%)	-6% (SD 17%)
Landscape	Biopesticide 95%	-5% (SD 7%)	7% (SD 21%)
Landscape	Biopesticide 100%	65% (SD 225%)	5% (SD 14%)

7.E ALL APHIDS

7.17 Baselines across countries

7.17.1 Whole landscape

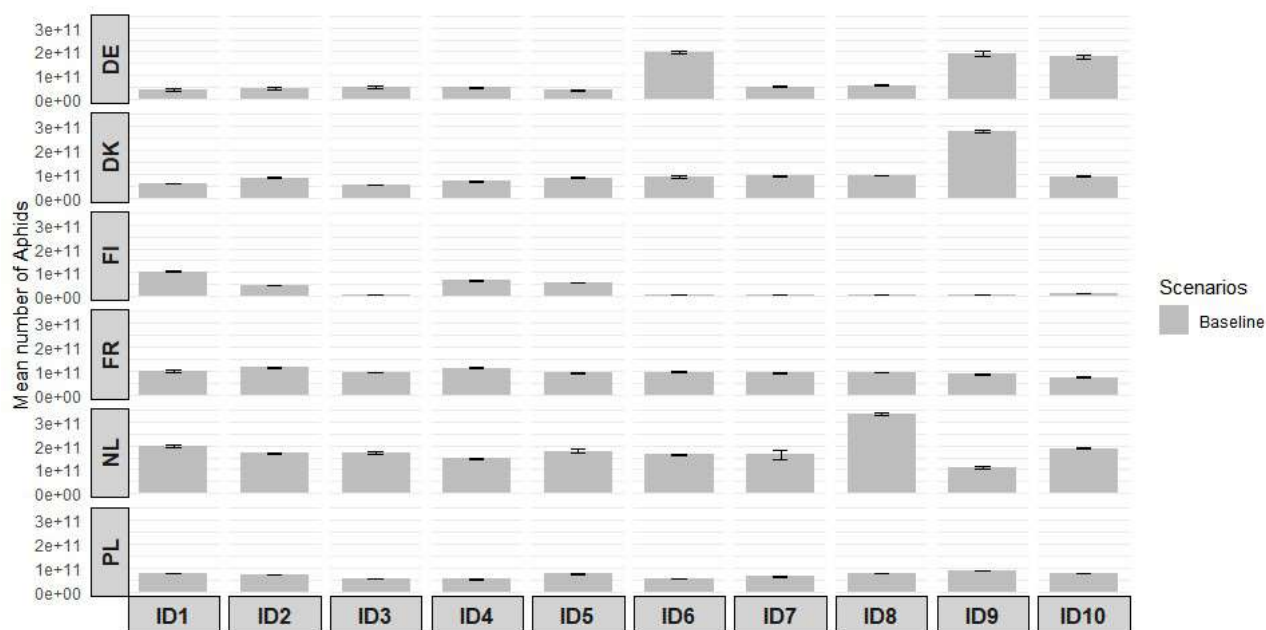


Figure 7.290 All aphids baselines for each country and landscape.

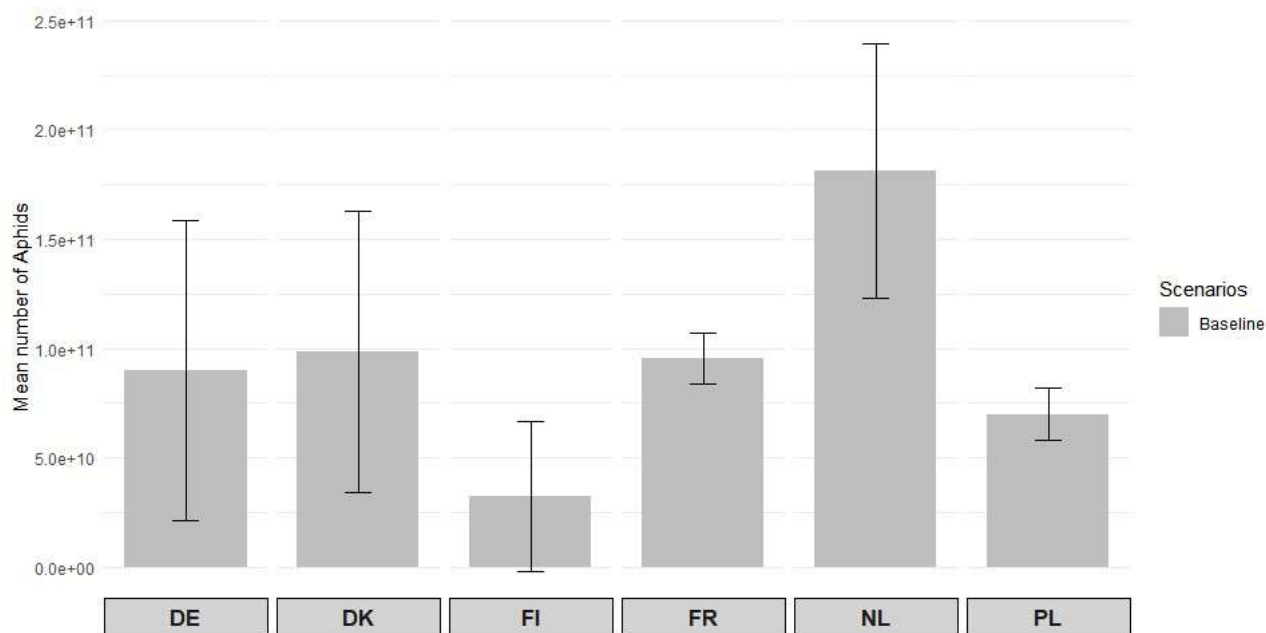


Figure 7.291 All aphids baselines for each country combined across landscapes.

7.17.2 In-field

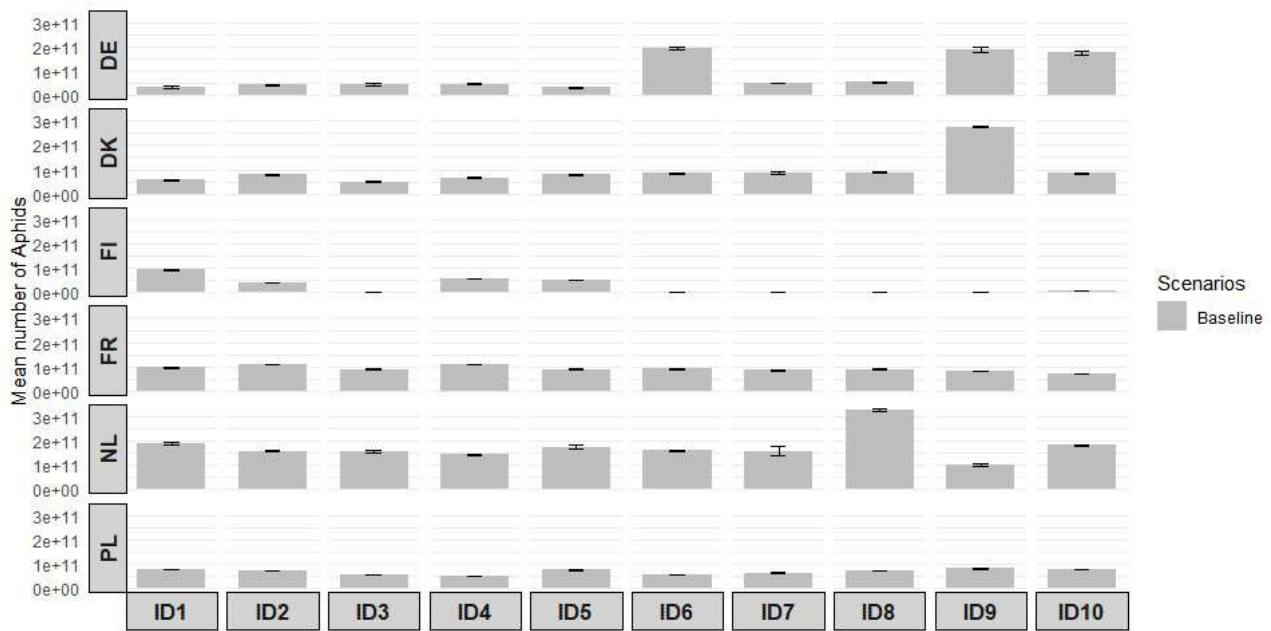


Figure 7.292 All aphids baselines for each country and landscape. All aphids in the fields only.

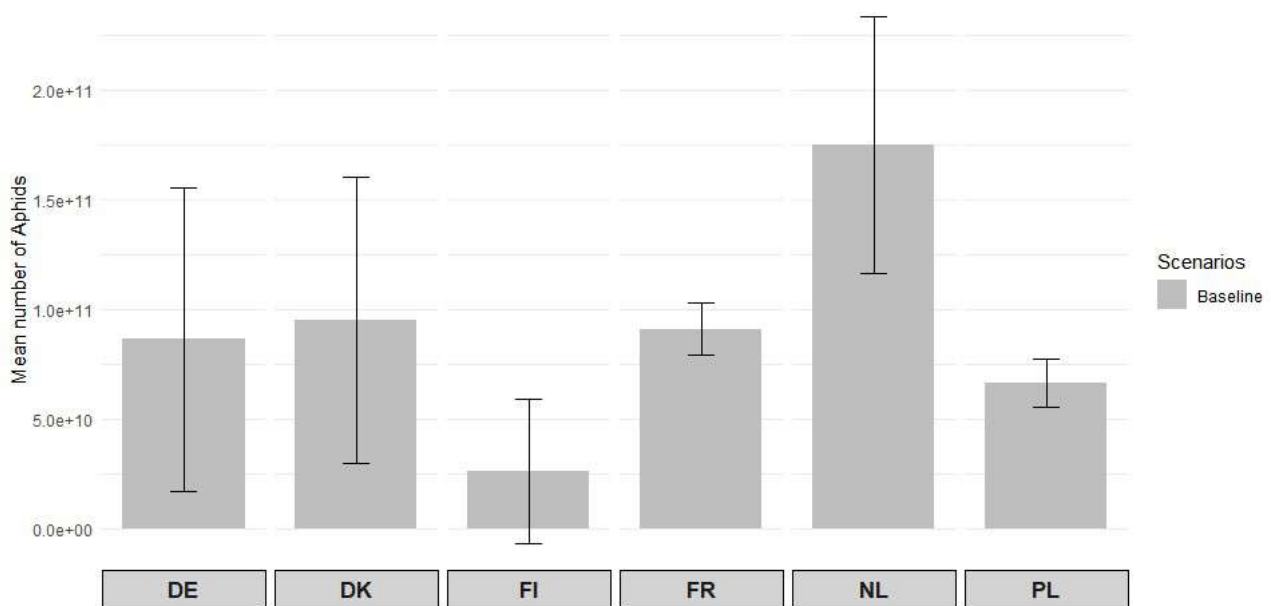


Figure 7.293 All aphids baselines for each country combined across landscapes. All aphids in the fields only.

7.17.3 In-field relative to landscape

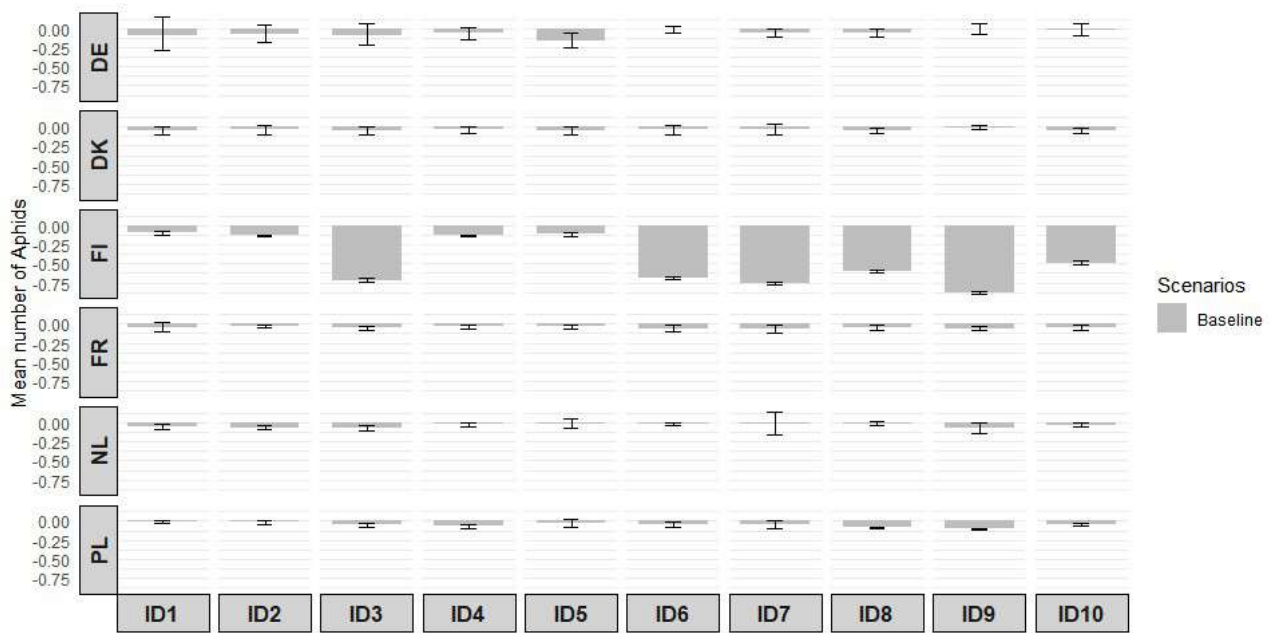


Figure 7.294 In-field relative to whole landscape comparison of All aphids baseline runs across countries and landscapes.

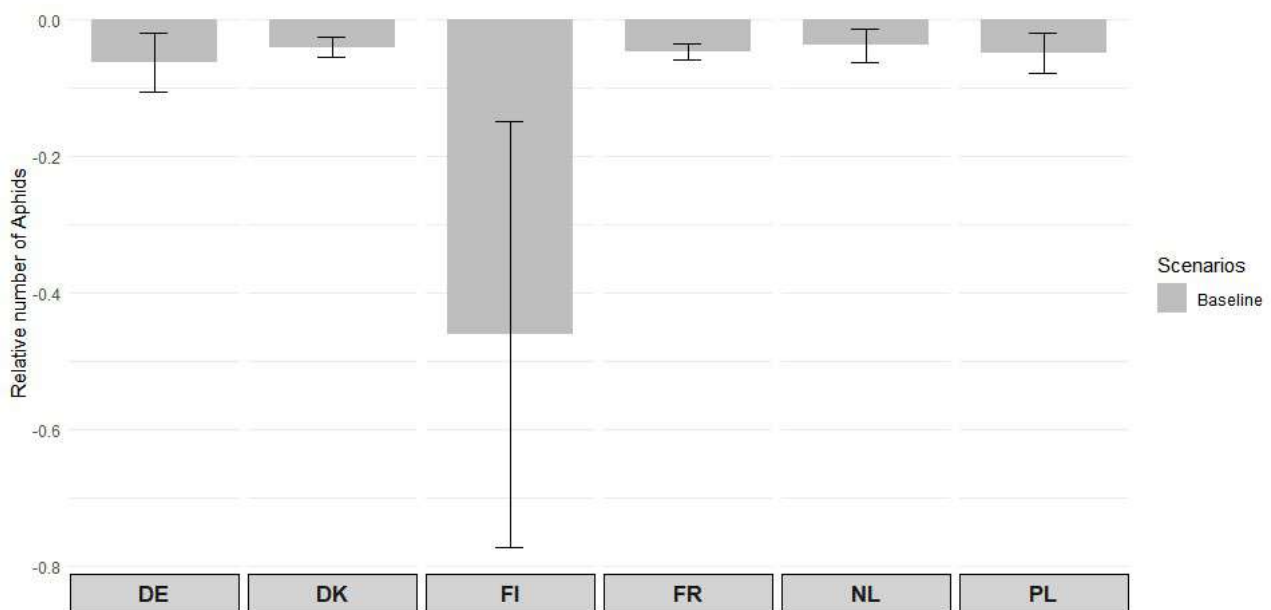


Figure 7.295 In-field relative to whole landscape comparison of All aphids baseline for each country across landscapes.

7.18 Germany

7.18.1 Flower field margins

7.18.1.1 Whole landscape

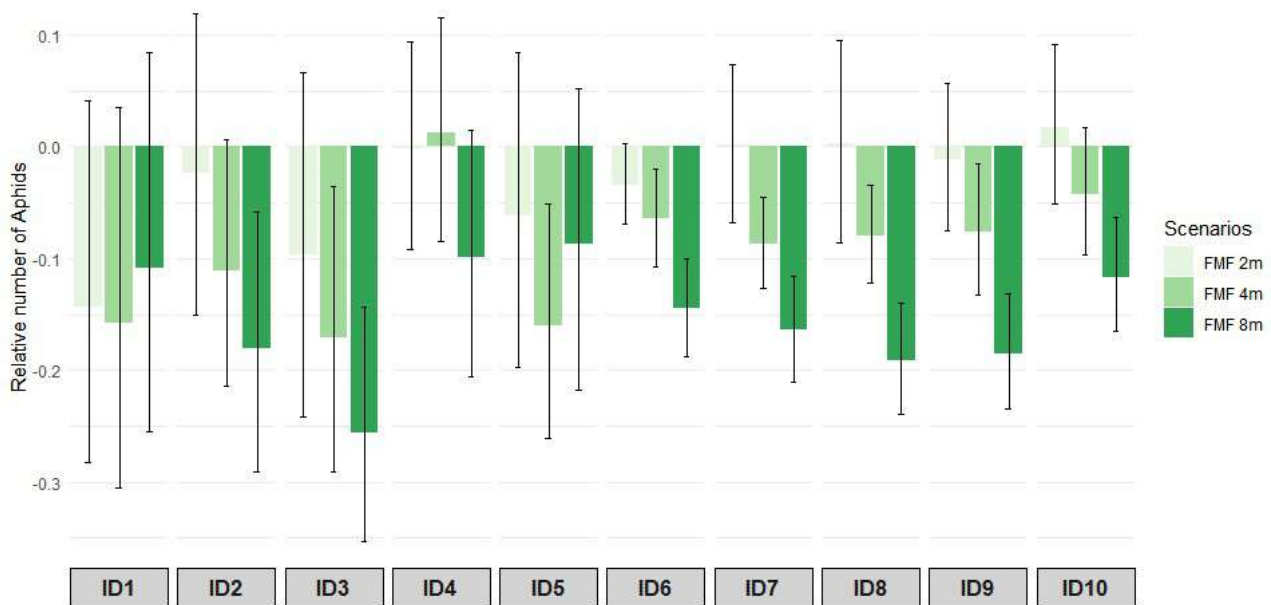


Figure 7.296 Flower field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.1.2 In-field

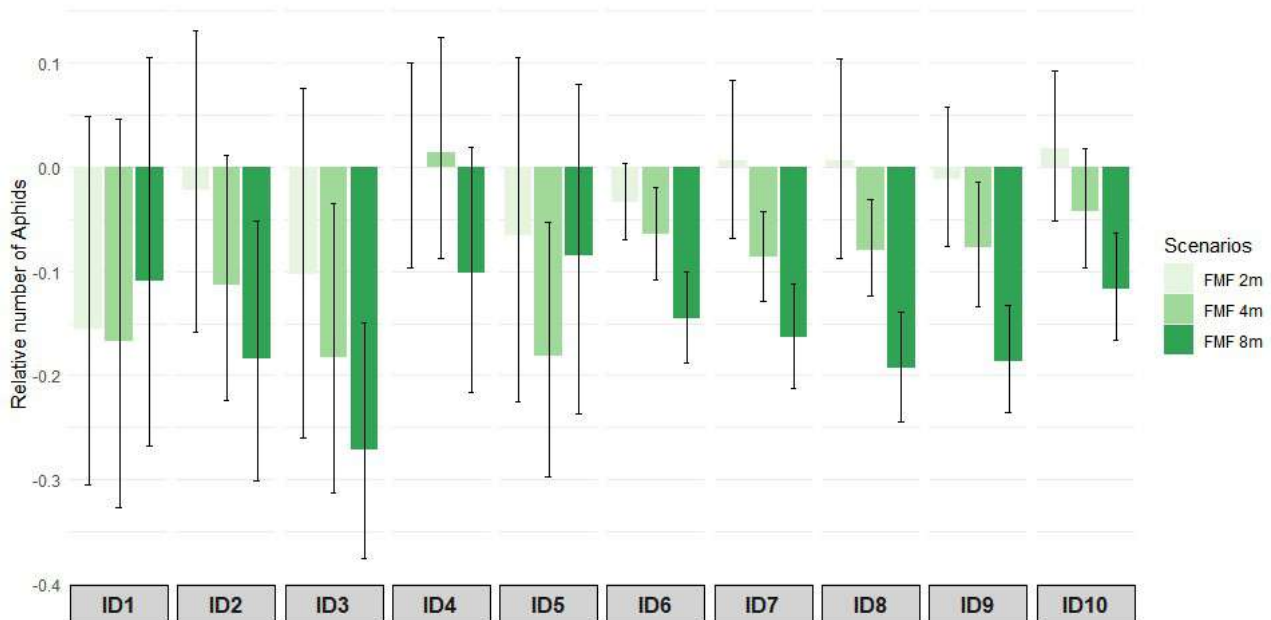


Figure 7.297 Flower field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.18.1.3 In-field relative to landscape

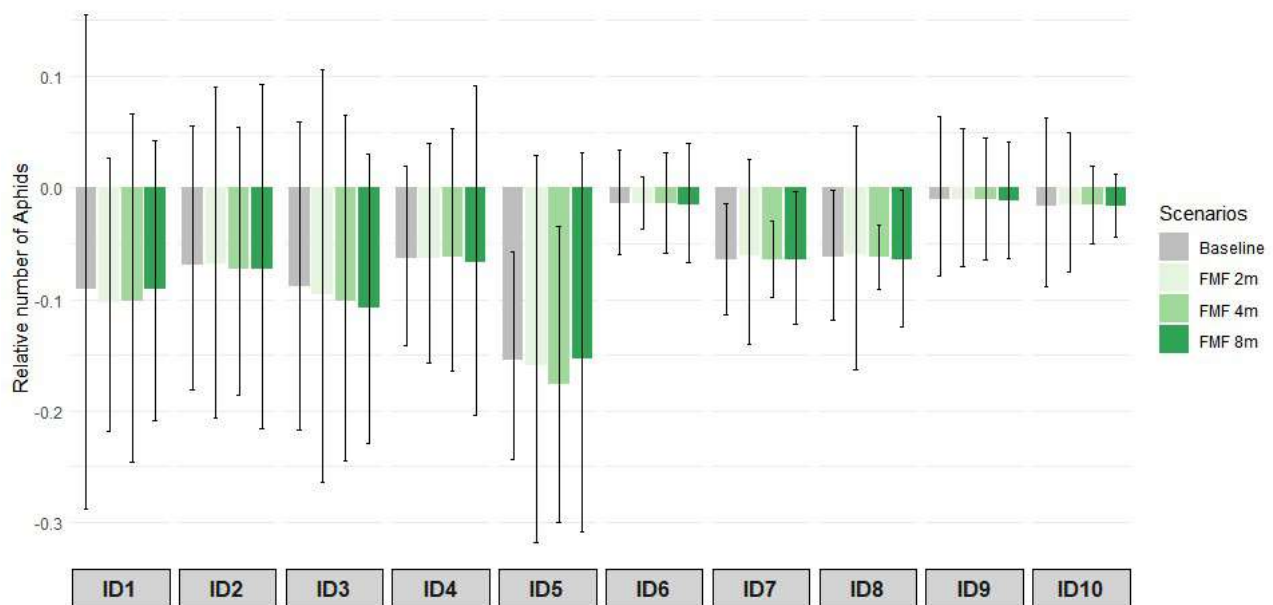


Figure 7.298 Flower field margins scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.18.2 Grass field margins

7.18.2.1 Whole landscape

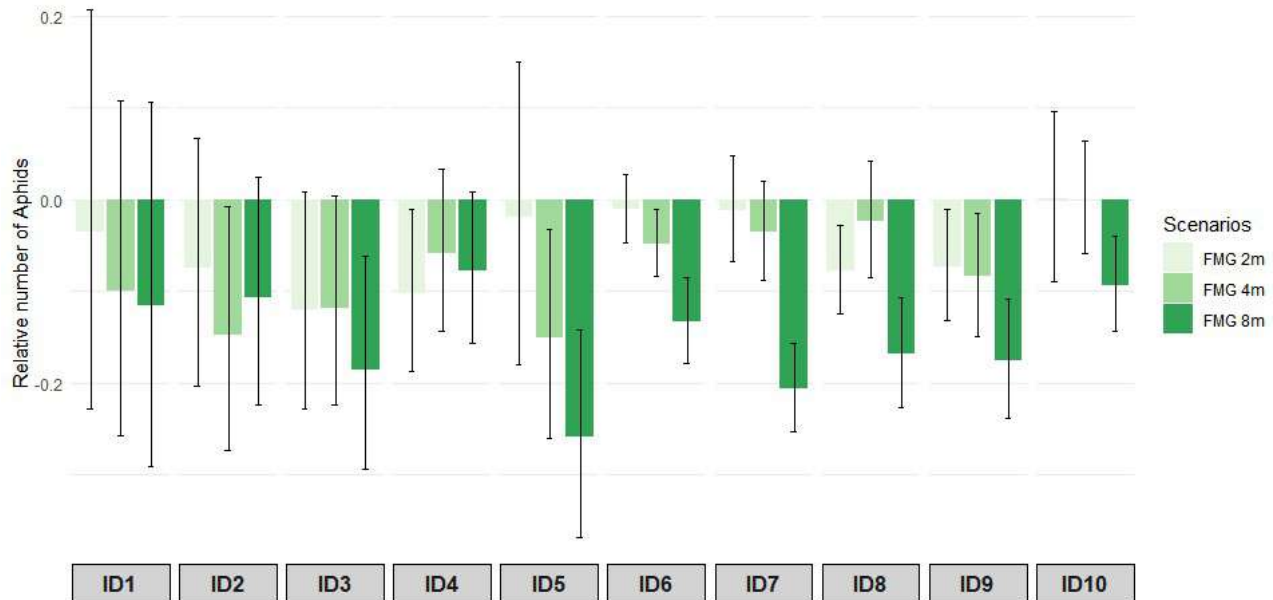


Figure 7.299 Grassy field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.2.2 In-field

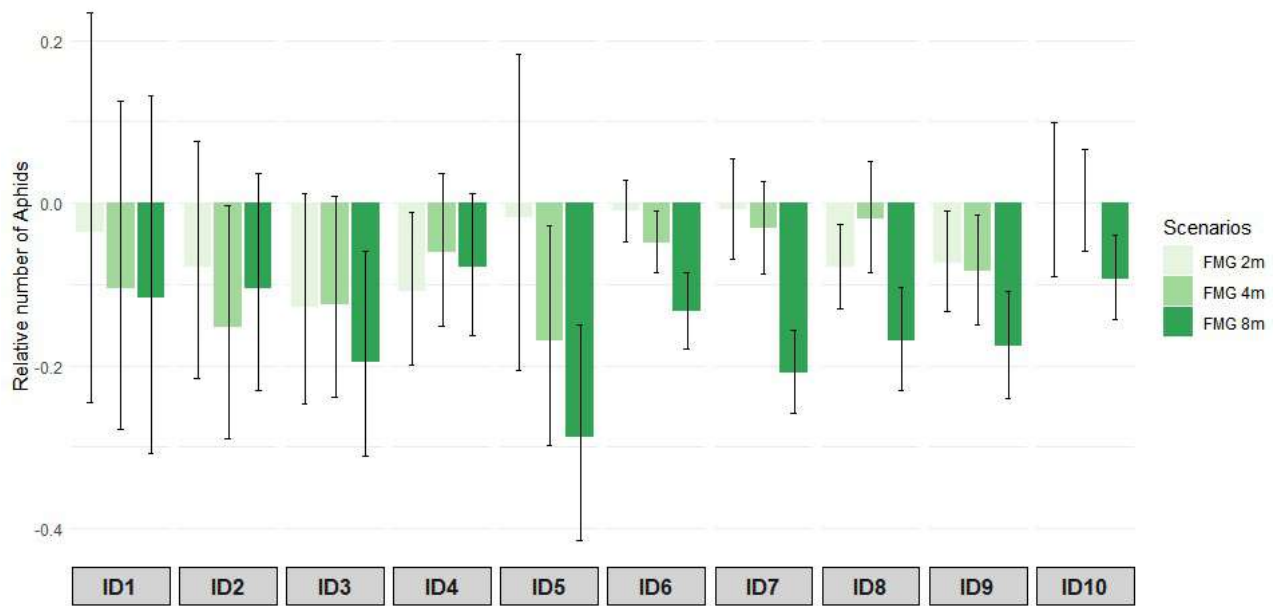


Figure 7.300 Grassy field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany..

7.18.2.3 In-field relative to landscape

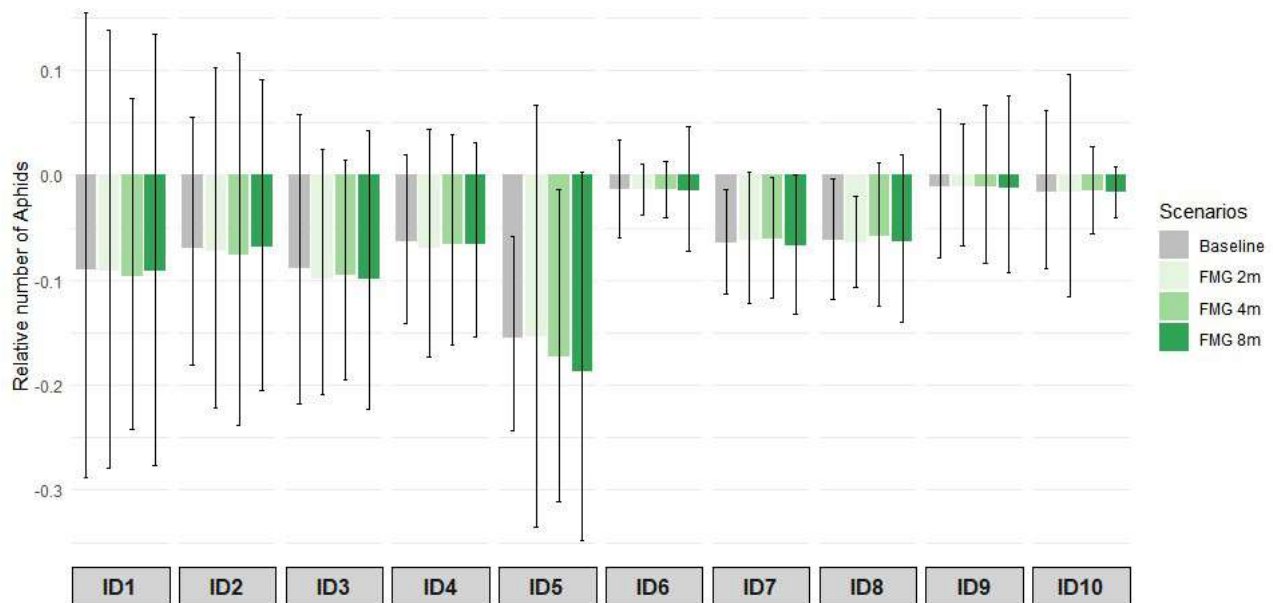


Figure 7.301 Grassy field margins scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.18.3 Mixed field margins

7.18.3.1 Whole landscape

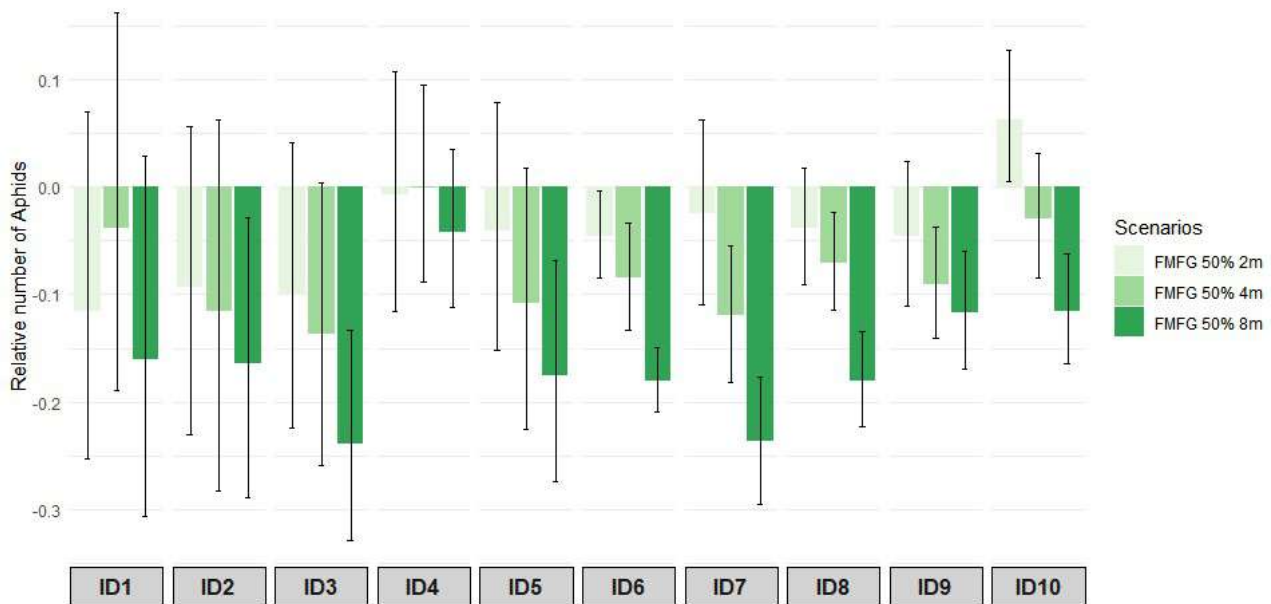


Figure 7.302 Mixed field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.3.2 In-field

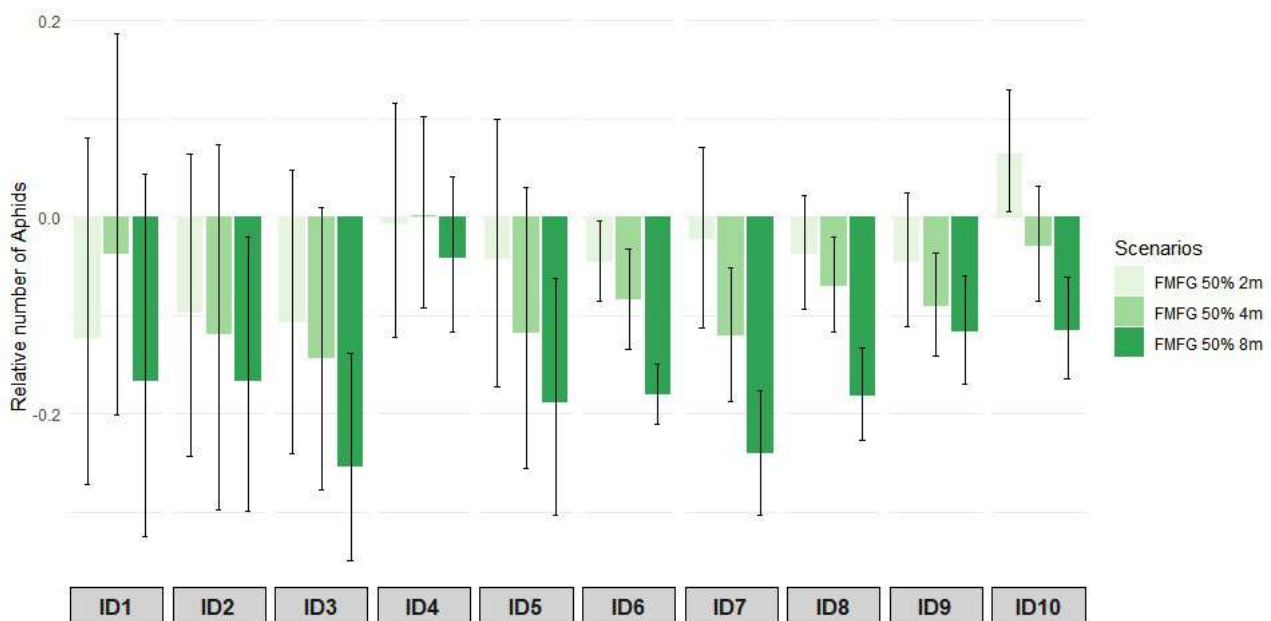


Figure 7.303 Mixed field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.18.3.3 In-field relative to landscape

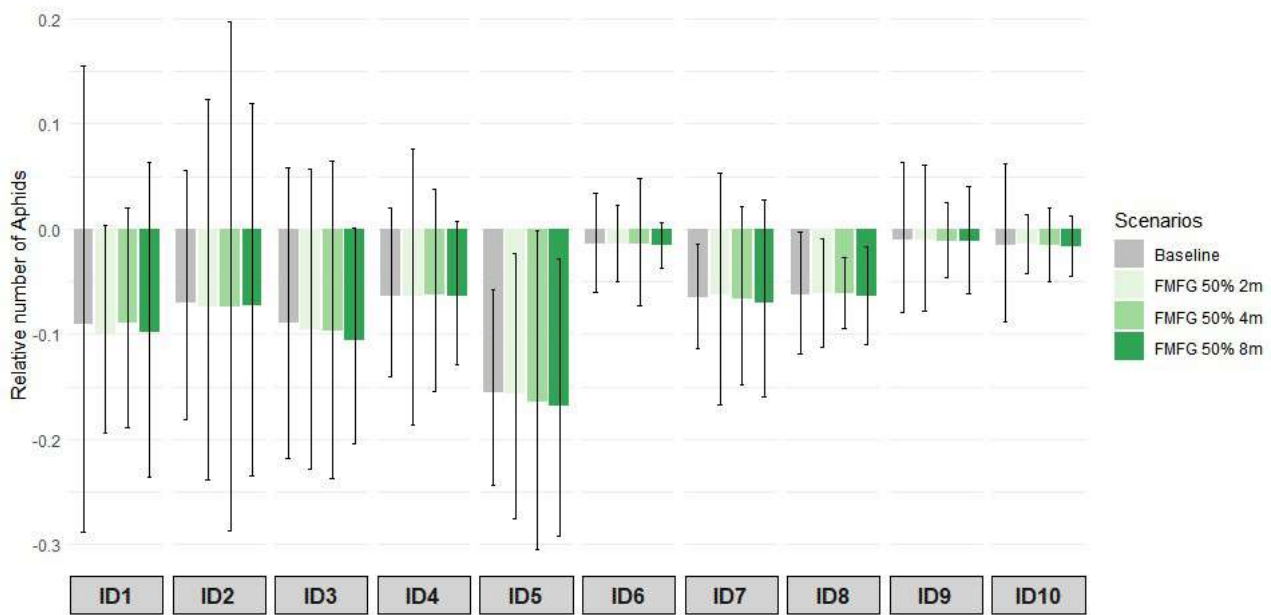


Figure 7.304 Mixed field margins scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.18.4 Flower, grassy and mixed margins

7.18.4.1 Whole landscape

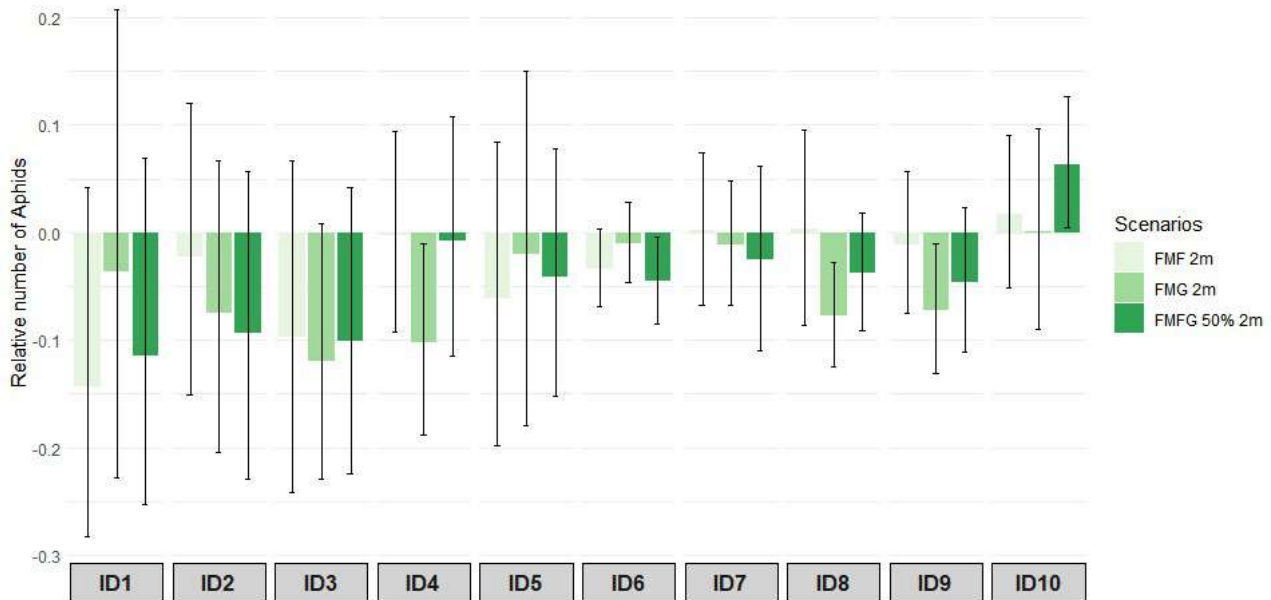


Figure 7.305 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

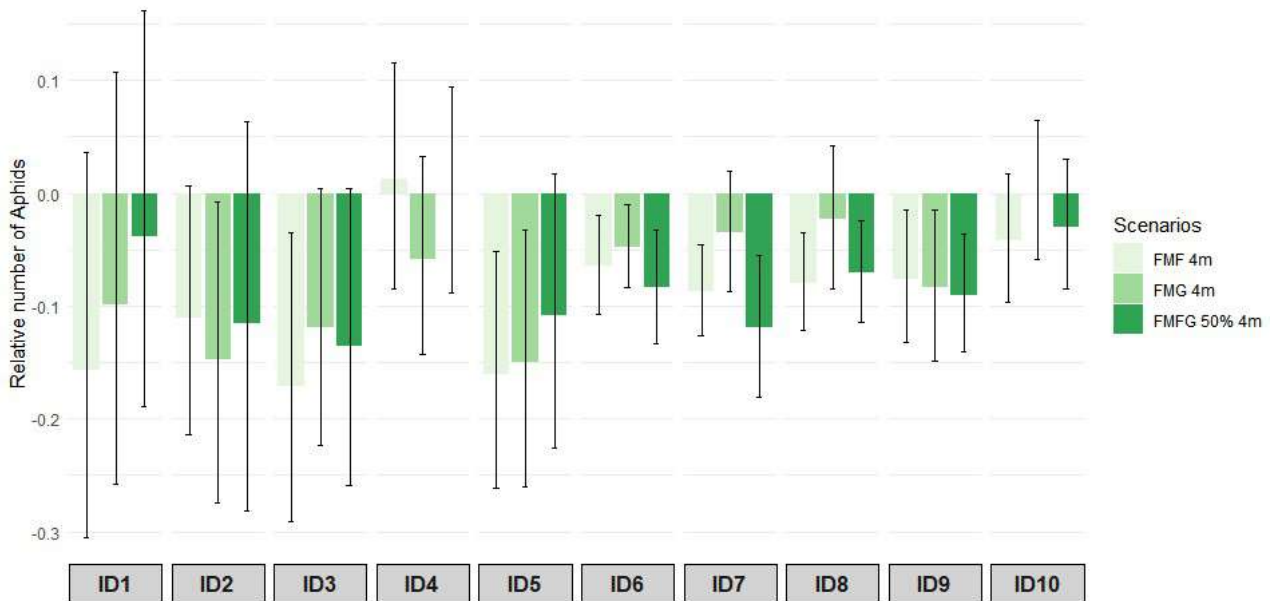


Figure 7.306 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.



Figure 7.307 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.4.2 In-field

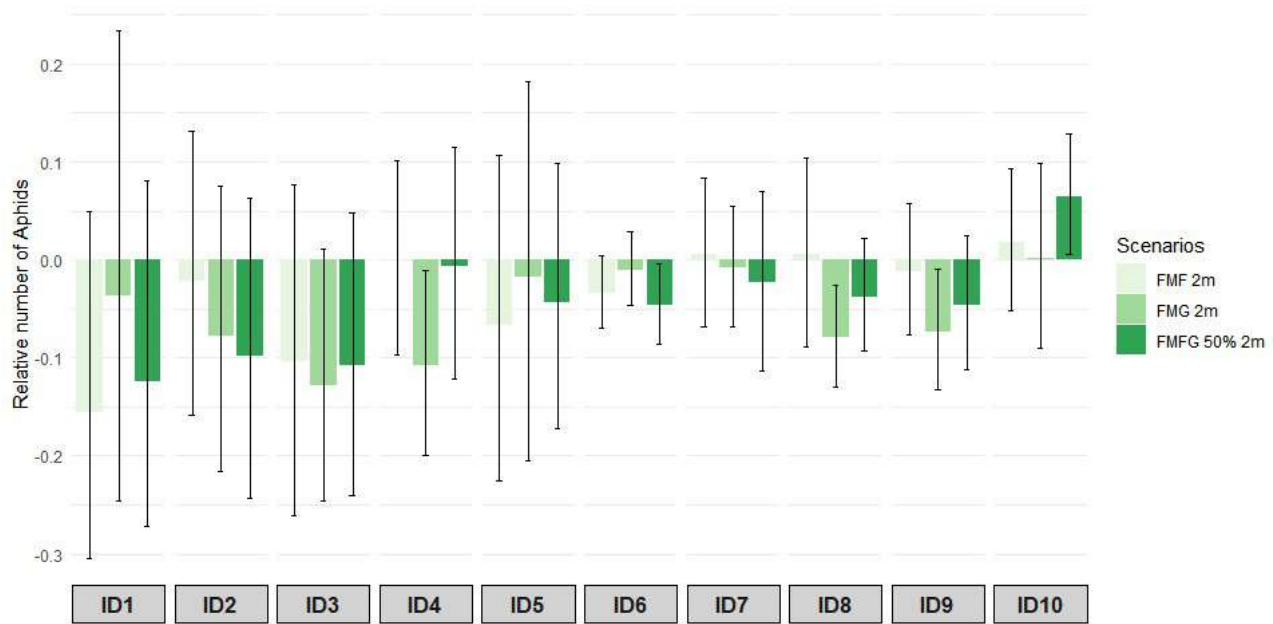


Figure 7.308 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

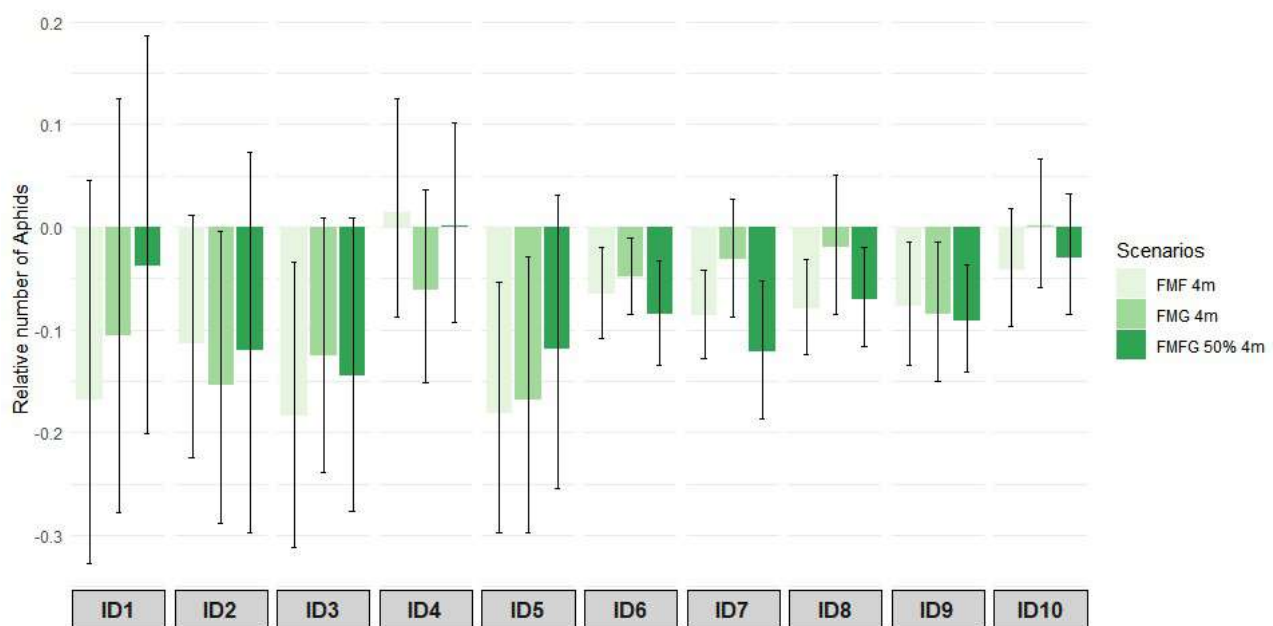


Figure 7.309 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

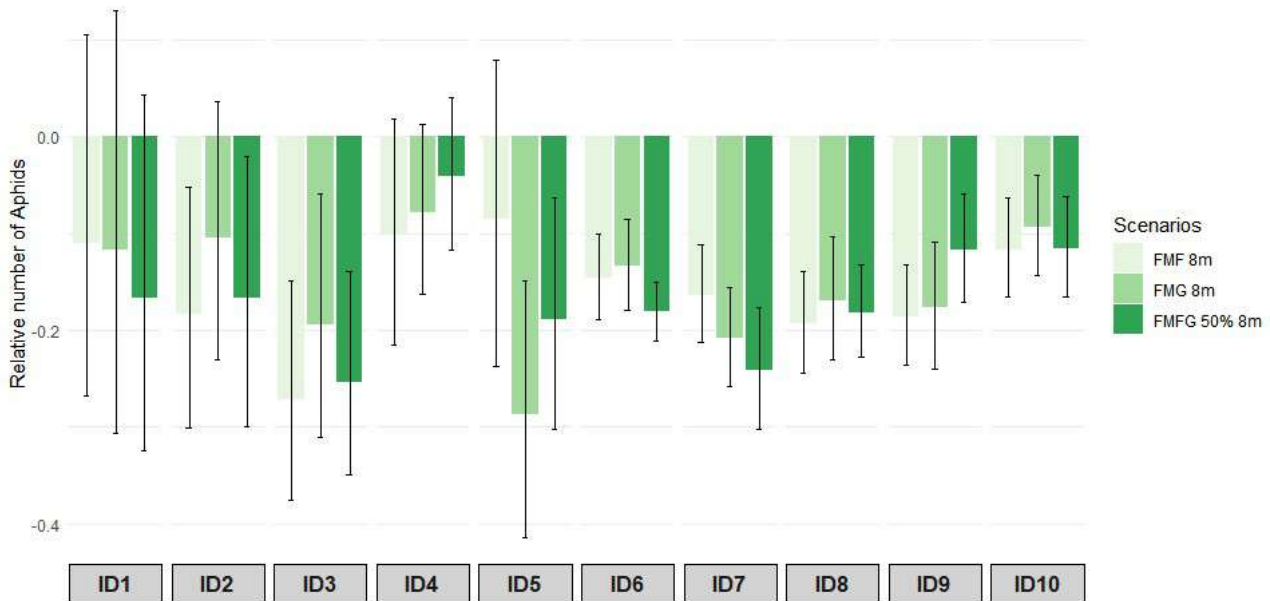


Figure 7.310 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.18.4.3 In-field relative to landscape

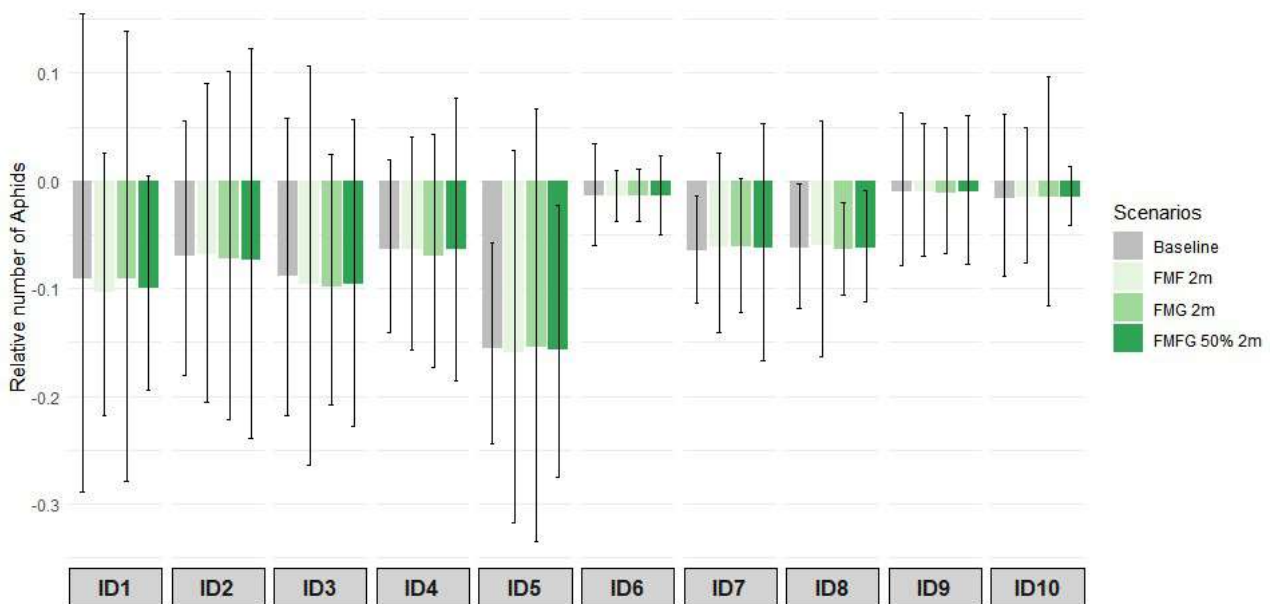


Figure 7.311 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

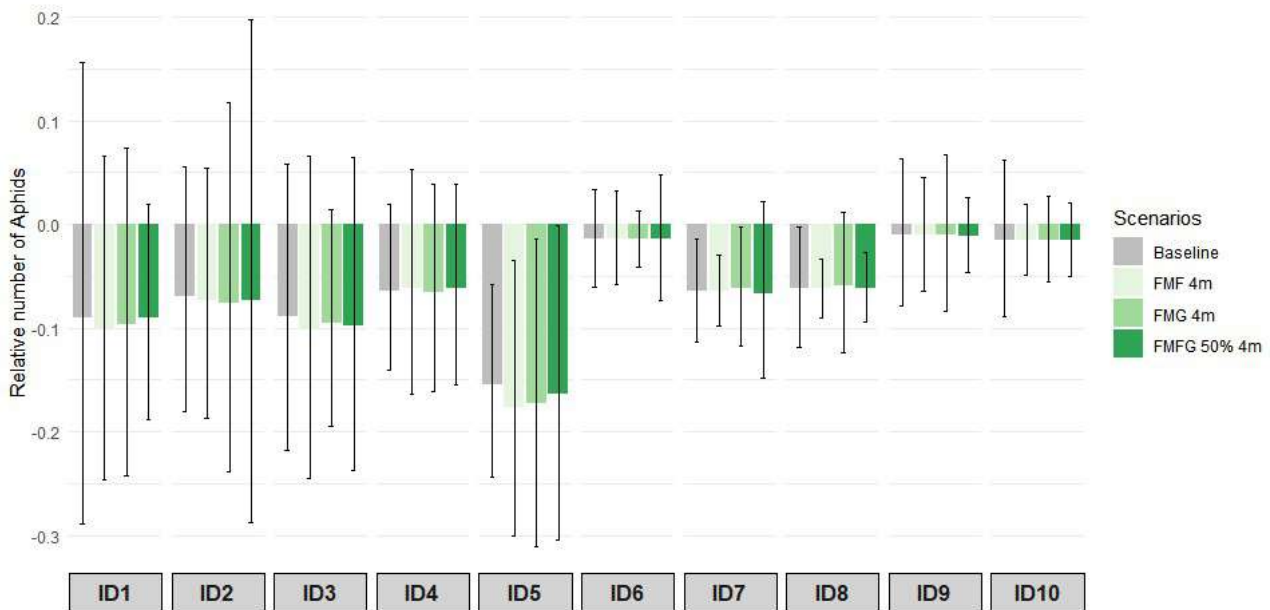


Figure 7.312 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

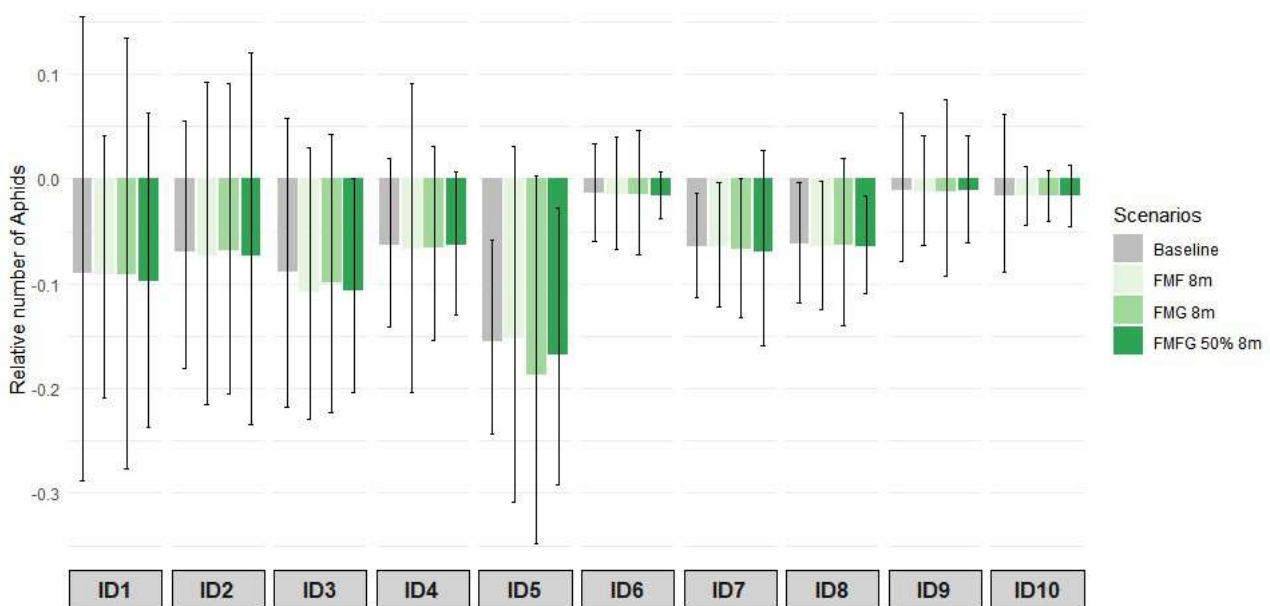


Figure 7.313 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.18.5 Setaside

7.18.5.1 Whole landscape

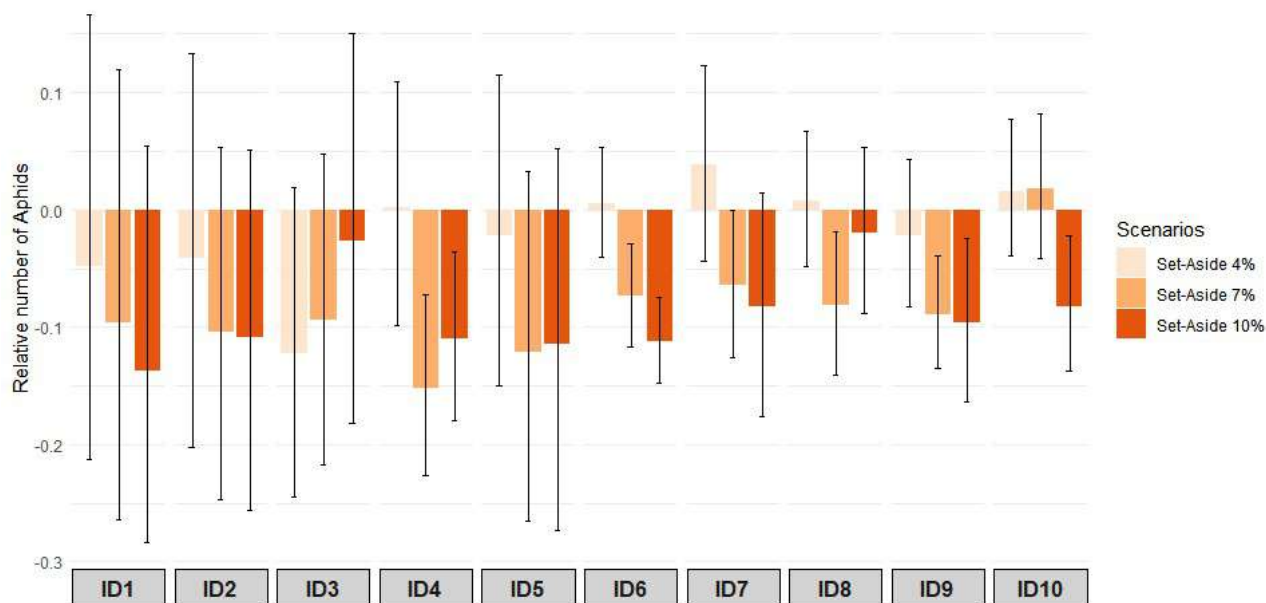


Figure 7.314 Setaside scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.5.2 In-field

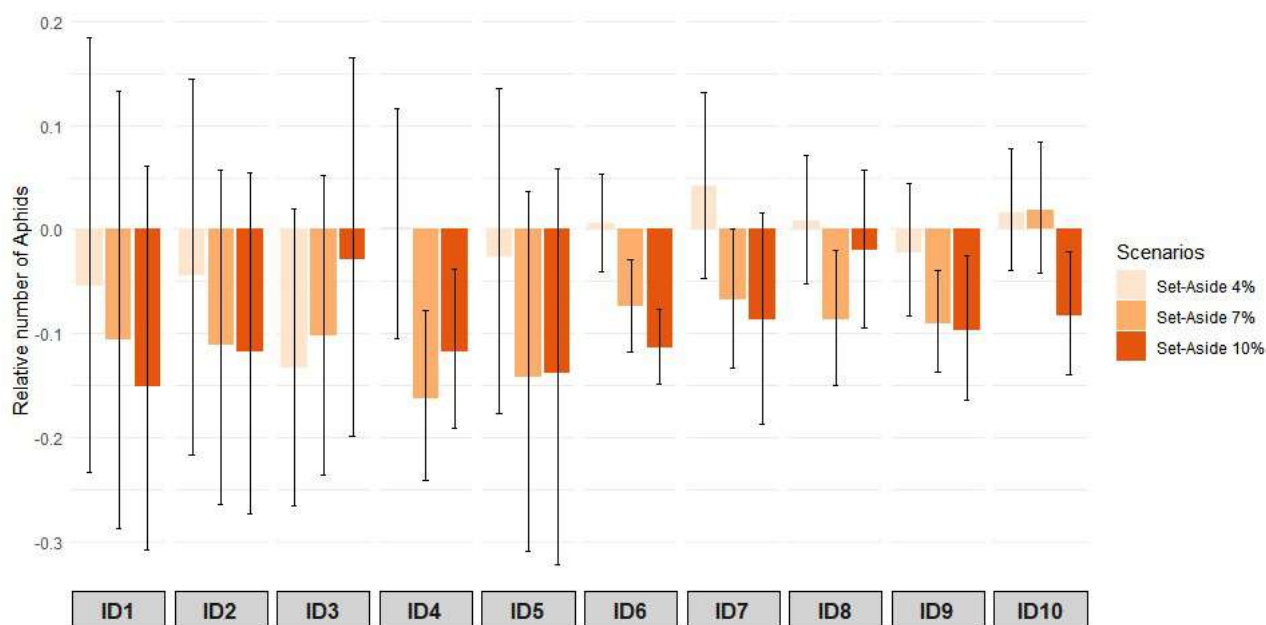


Figure 7.315 Setaside scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.18.5.3 In-field relative to landscape

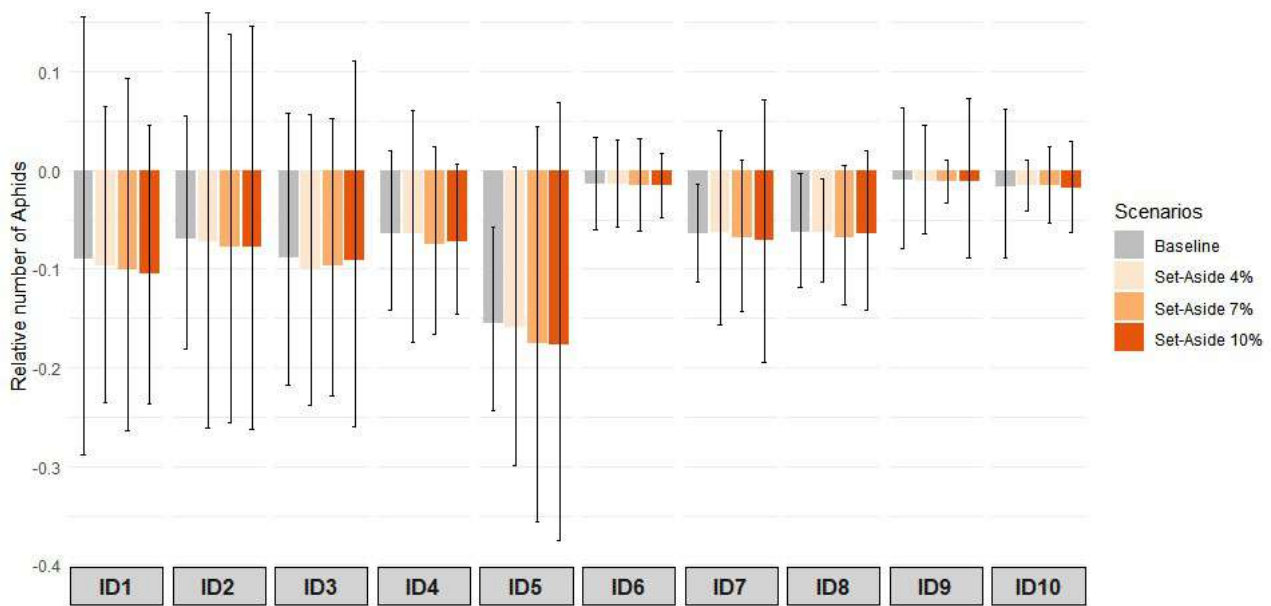


Figure 7.316 Setaside scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.18.6 Legume

7.18.6.1 Whole landscape

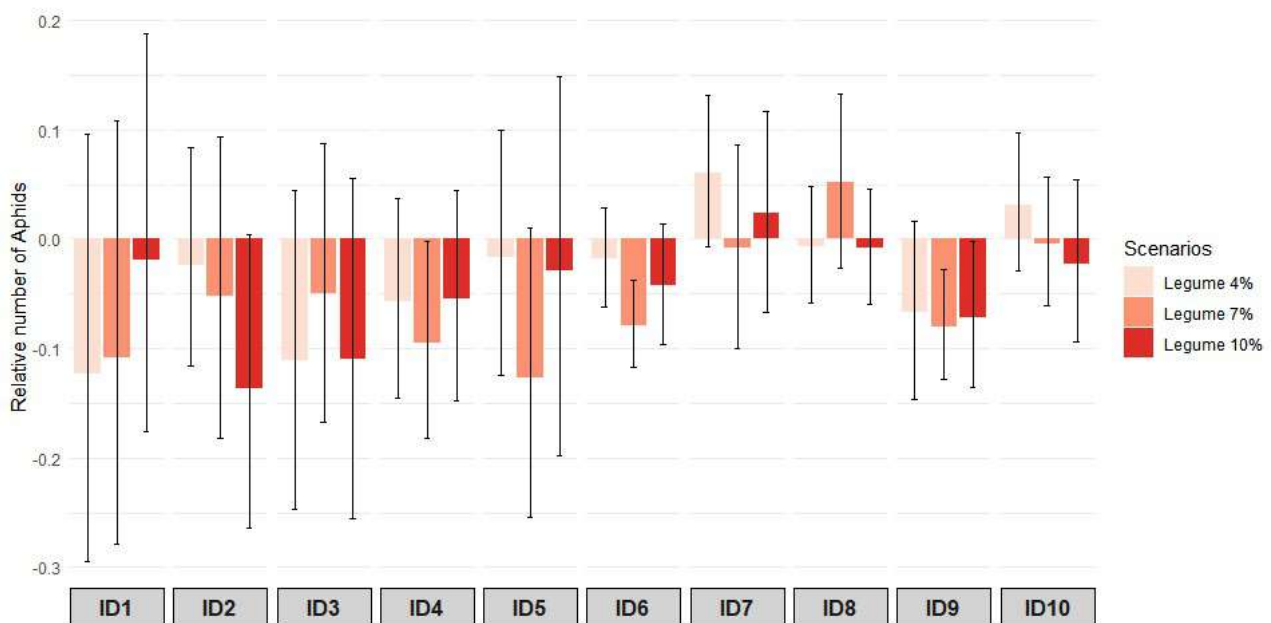


Figure 7.317 Legume scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.6.2 In-field

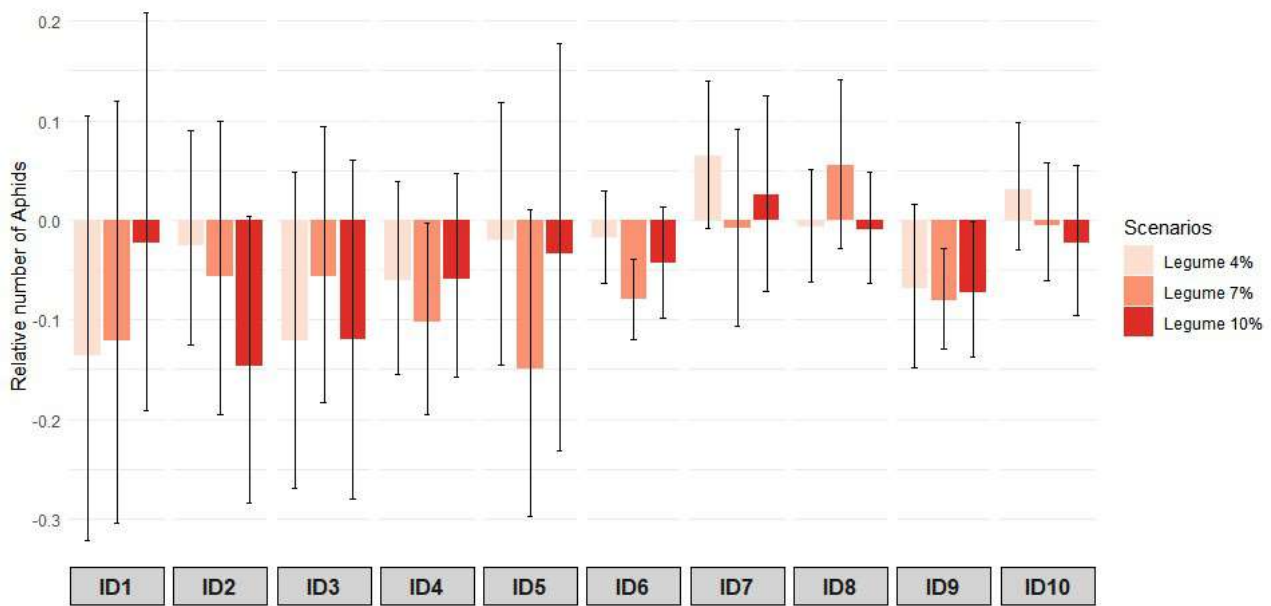


Figure 7.318 Legume scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.18.6.3 In-field relative to landscape

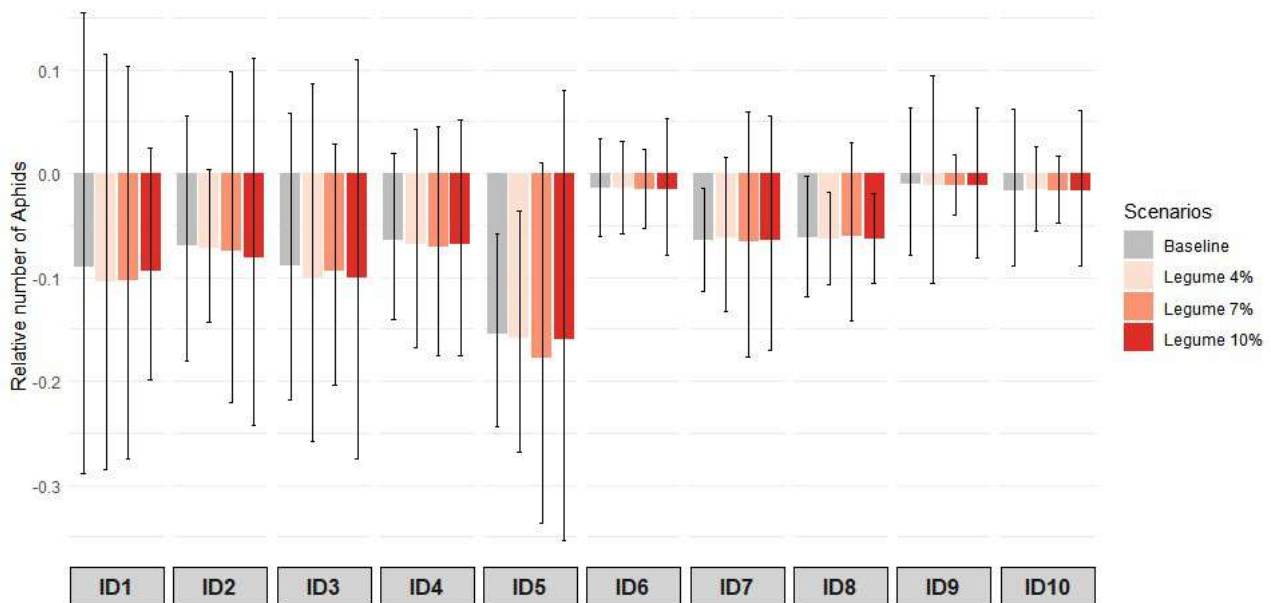


Figure 7.319 Legume scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.18.7 Biopesticides

7.18.7.1 Whole landscape

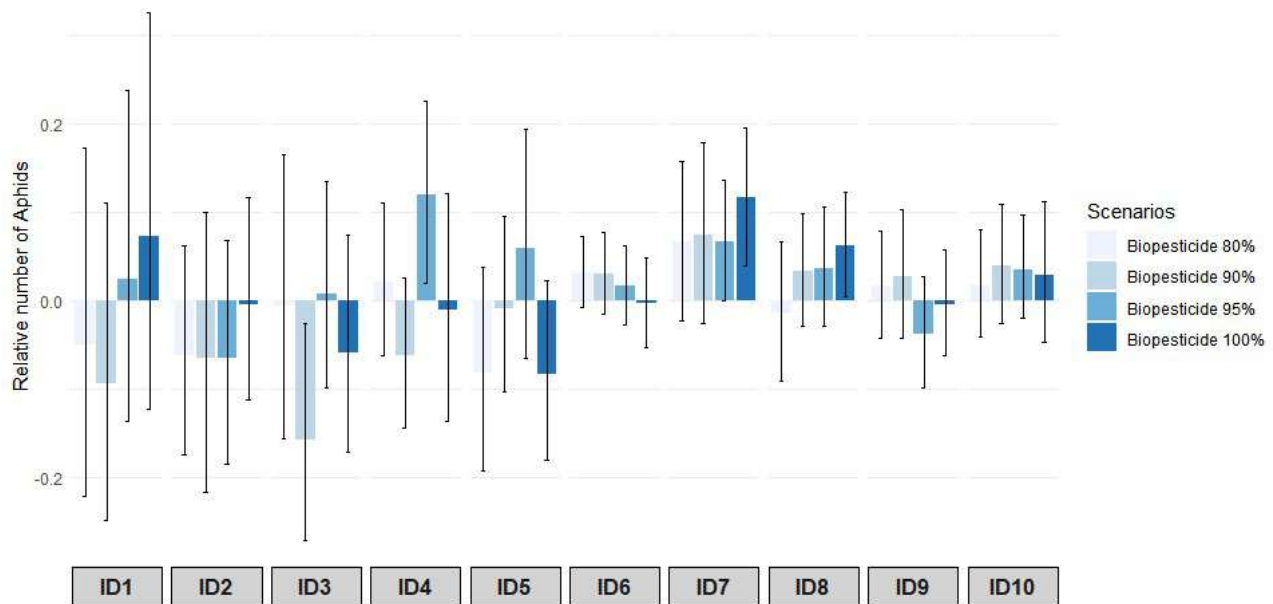


Figure 7.320 Biopesticide scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Germany.

7.18.7.2 In-field

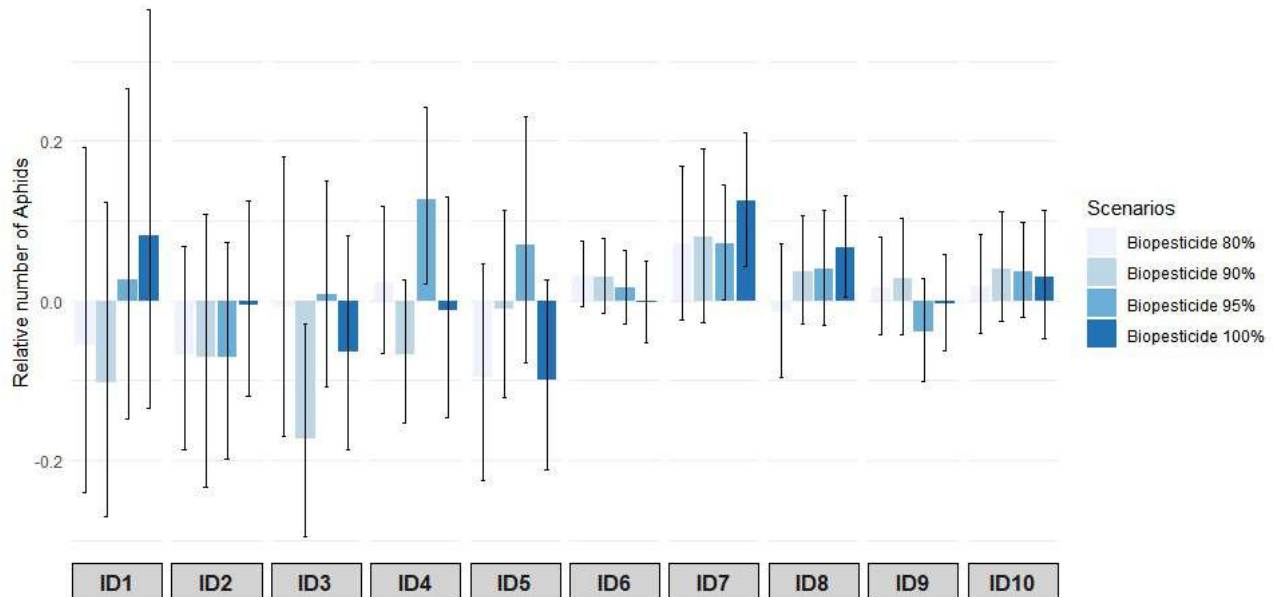


Figure 7.321 Biopesticide scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Germany.

7.18.7.3 In-field relative to landscape

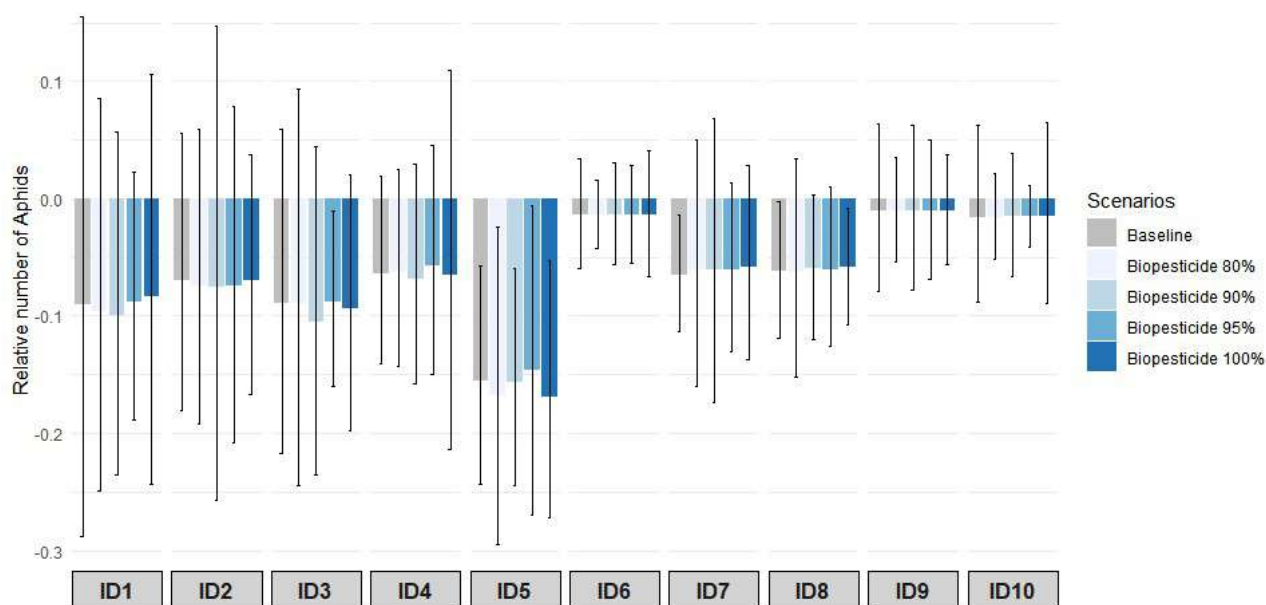


Figure 7.322 Biopesticide scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Germany.

7.19 Denmark

7.19.1 Crop diversification

7.19.1.1 Whole landscape

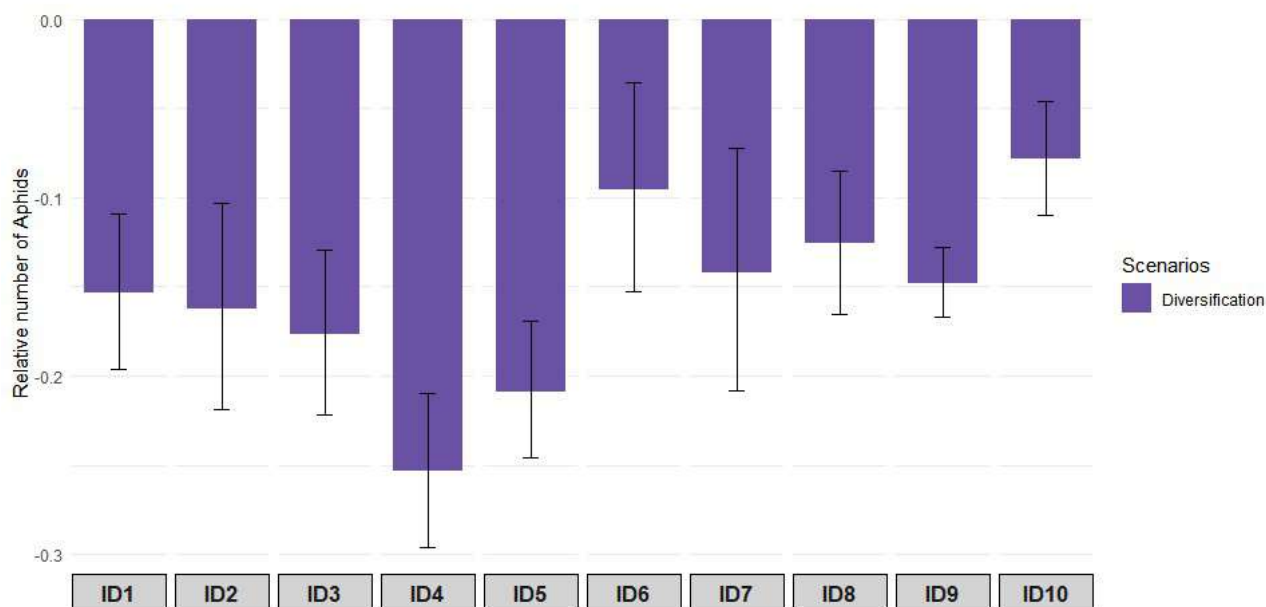


Figure 7.323 Diversification scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark..

7.19.1.2 In-field

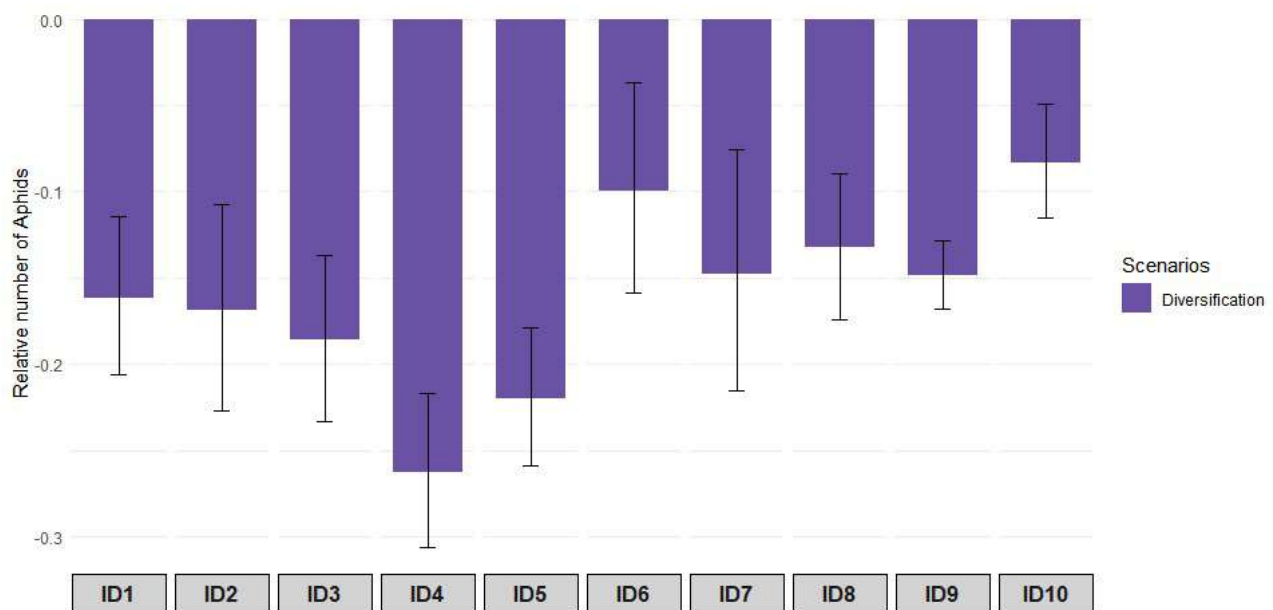


Figure 7.324 Diversification scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.19.1.3 In-field relative to landscape

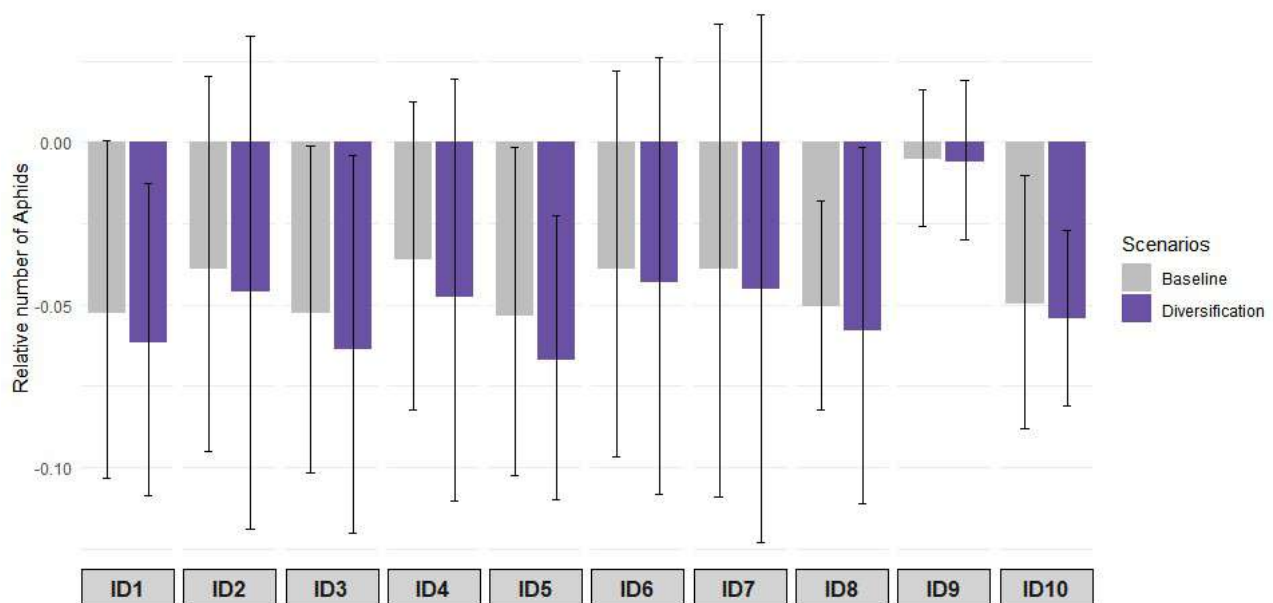


Figure 7.325 Diversification scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.2 Flower field margins

7.19.2.1 Whole landscape

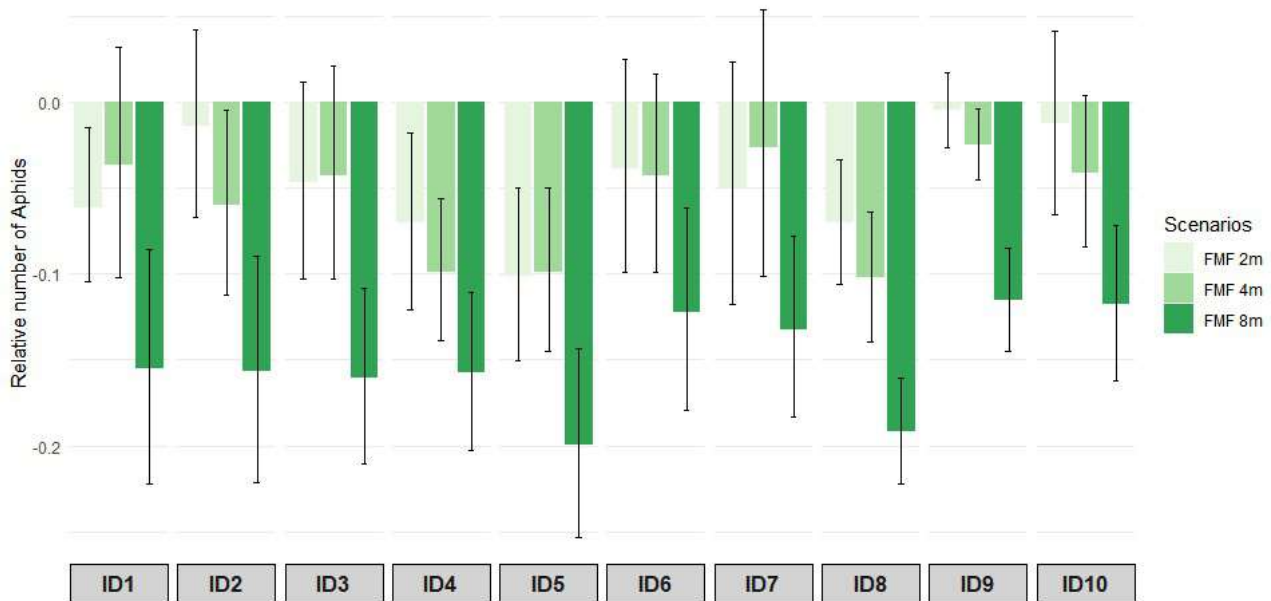


Figure 7.326 Flower field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.2.2 In-field

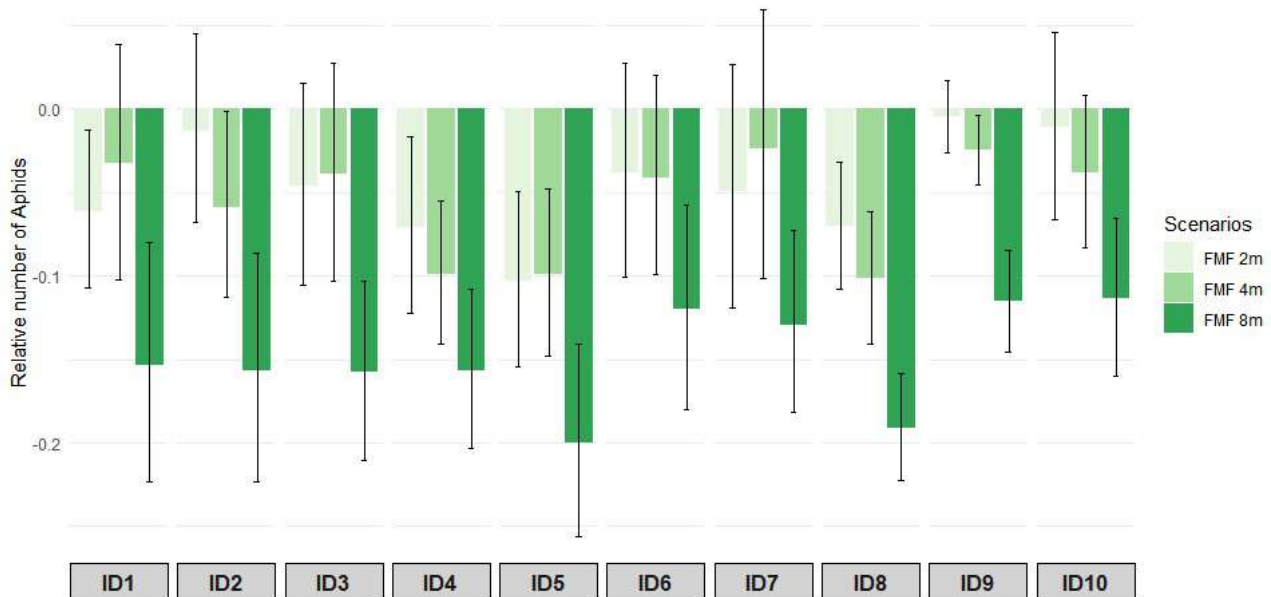


Figure 7.327 Flower field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.19.2.3 In-field relative to landscape

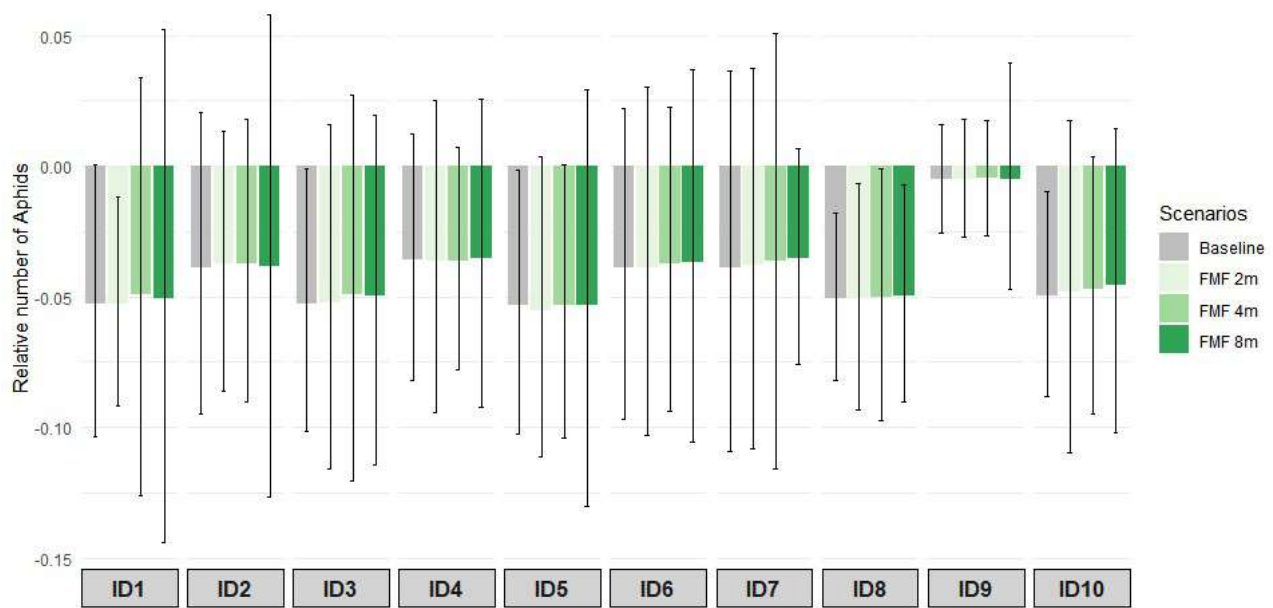


Figure 7.328 Flower field margins scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.3 Grass field margins

7.19.3.1 Whole landscape

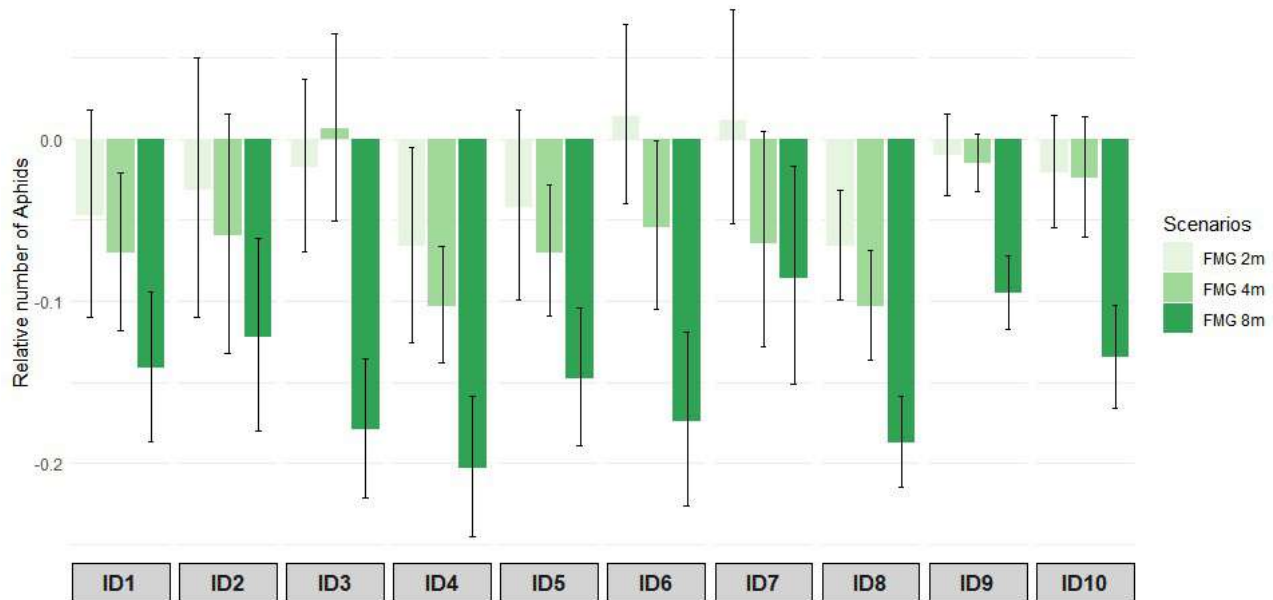


Figure 7.329 Grassy field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.3.2 In-field

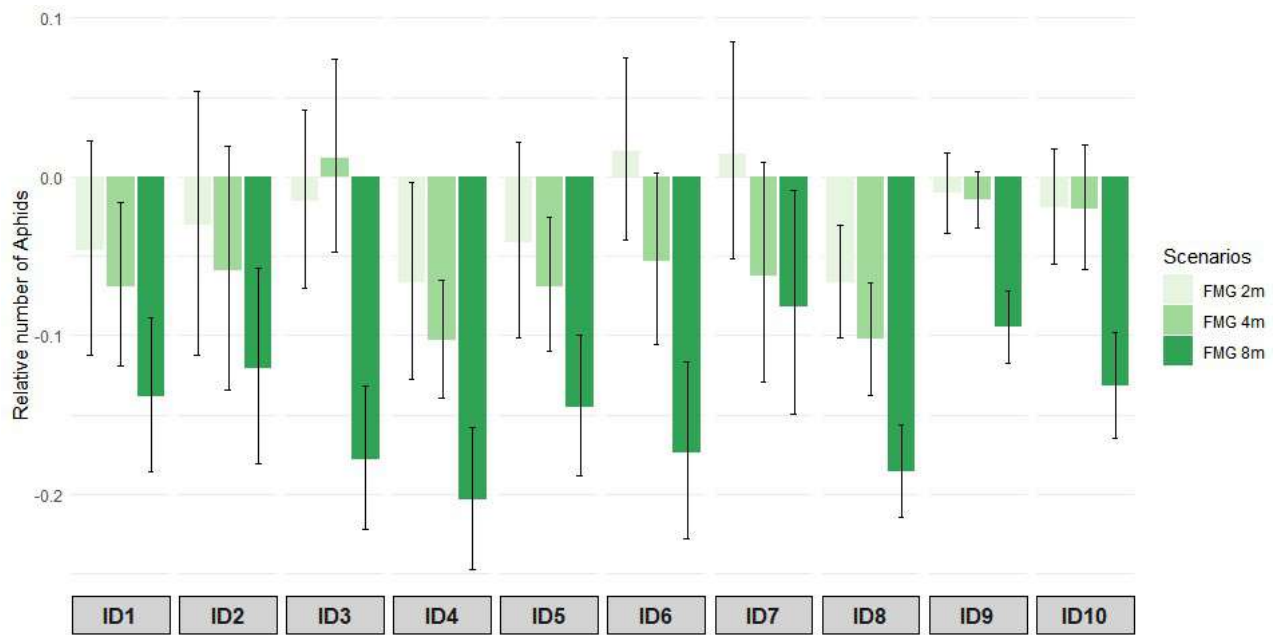


Figure 7.330 Grassy field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.19.3.3 In-field relative to landscape

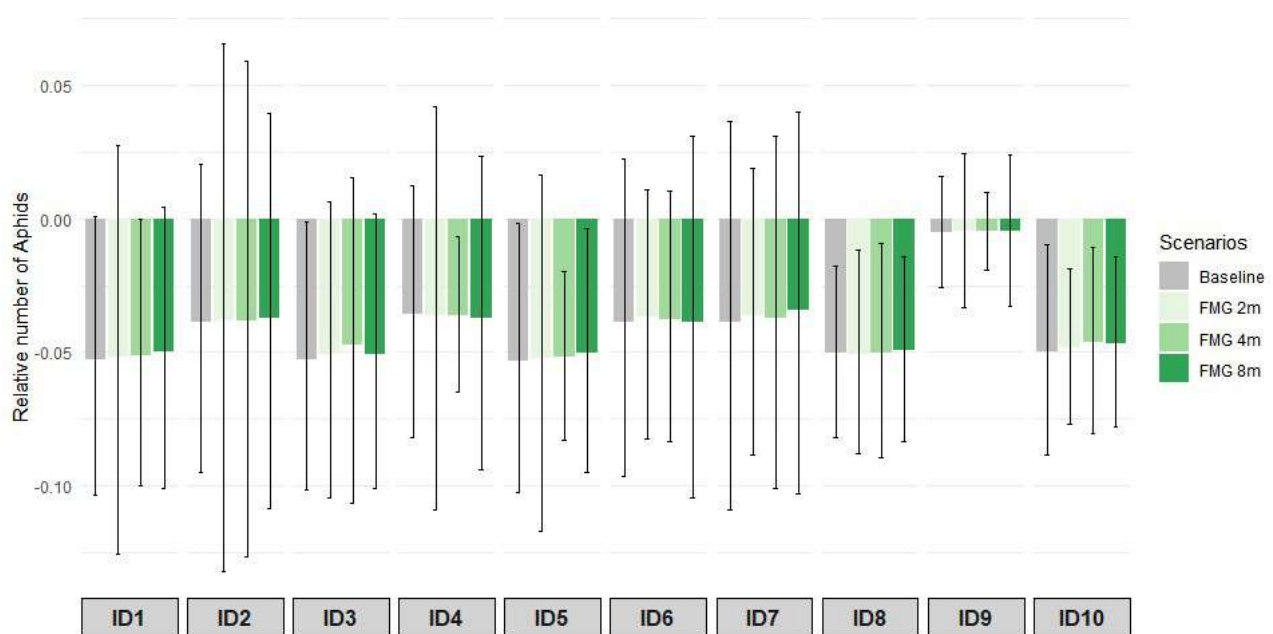


Figure 7.331 Grassy field margins scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.4 Mixed field margins

7.19.4.1 Whole landscape

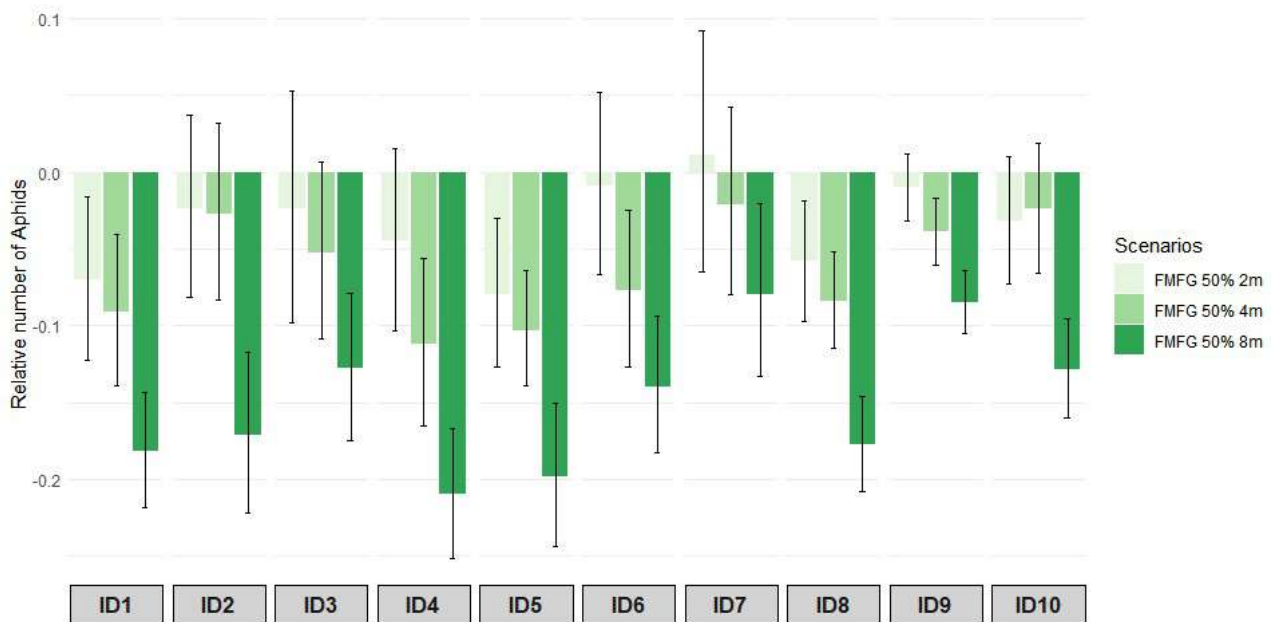


Figure 7.332 Mixed field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.4.2 In-field

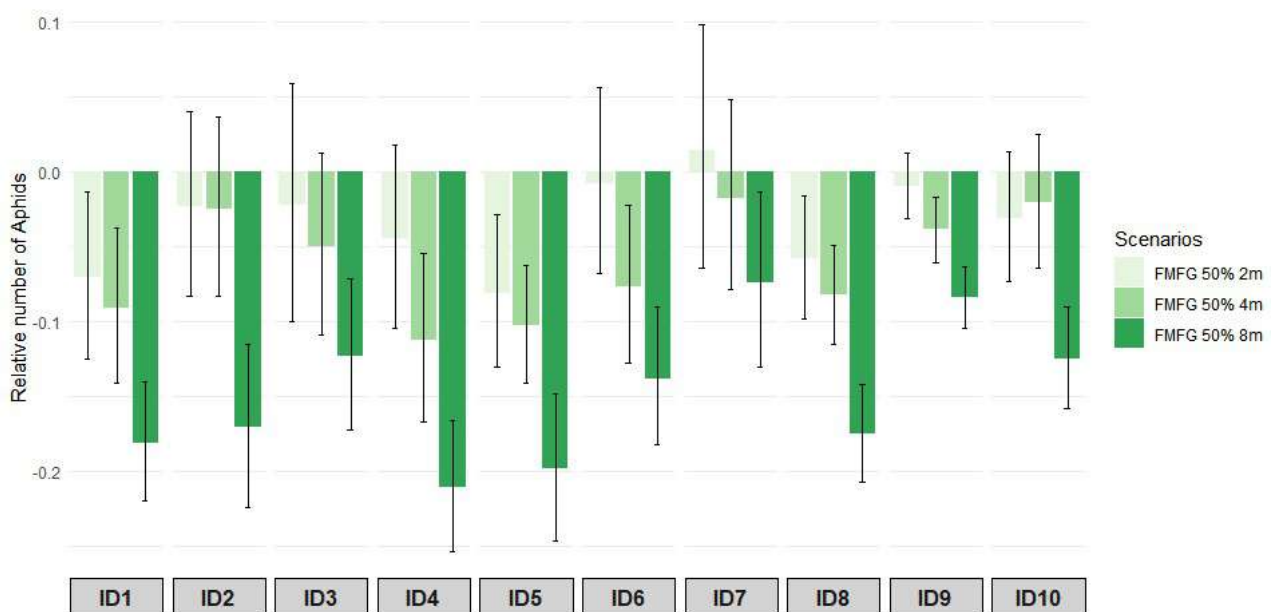


Figure 7.333 Mixed field margins scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark

7.19.4.3 In-field relative to landscape

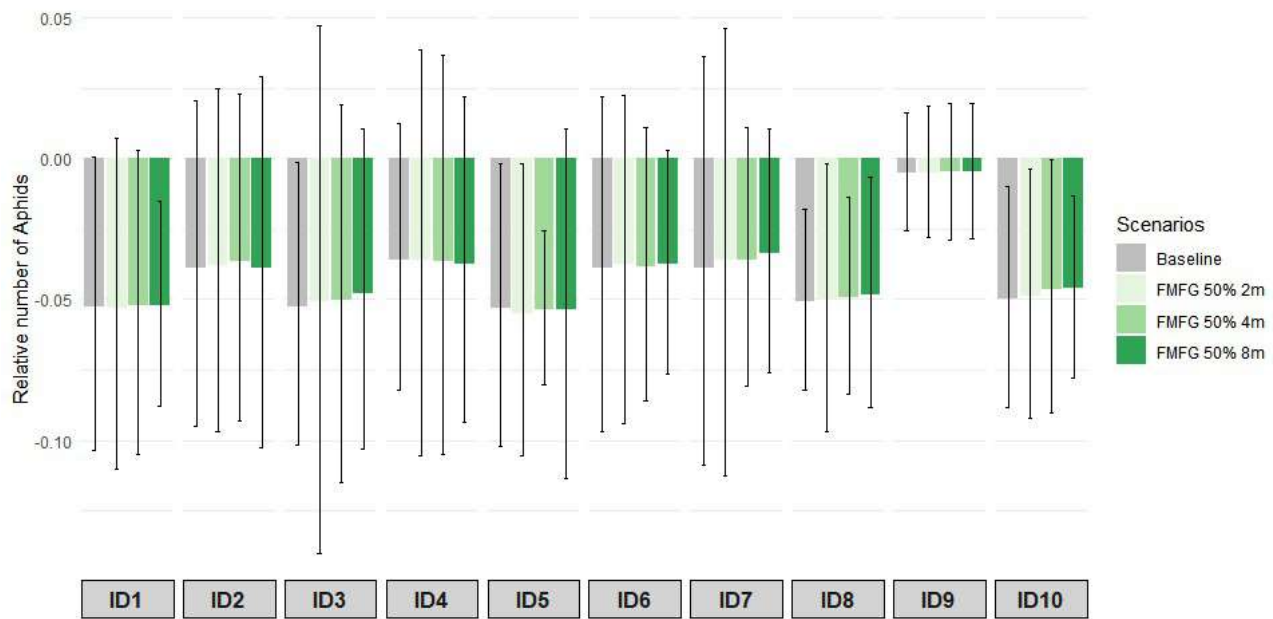


Figure 7.334 Mixed field margins scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.5 Flower, grassy and mixed margins

7.19.5.1 Whole landscape

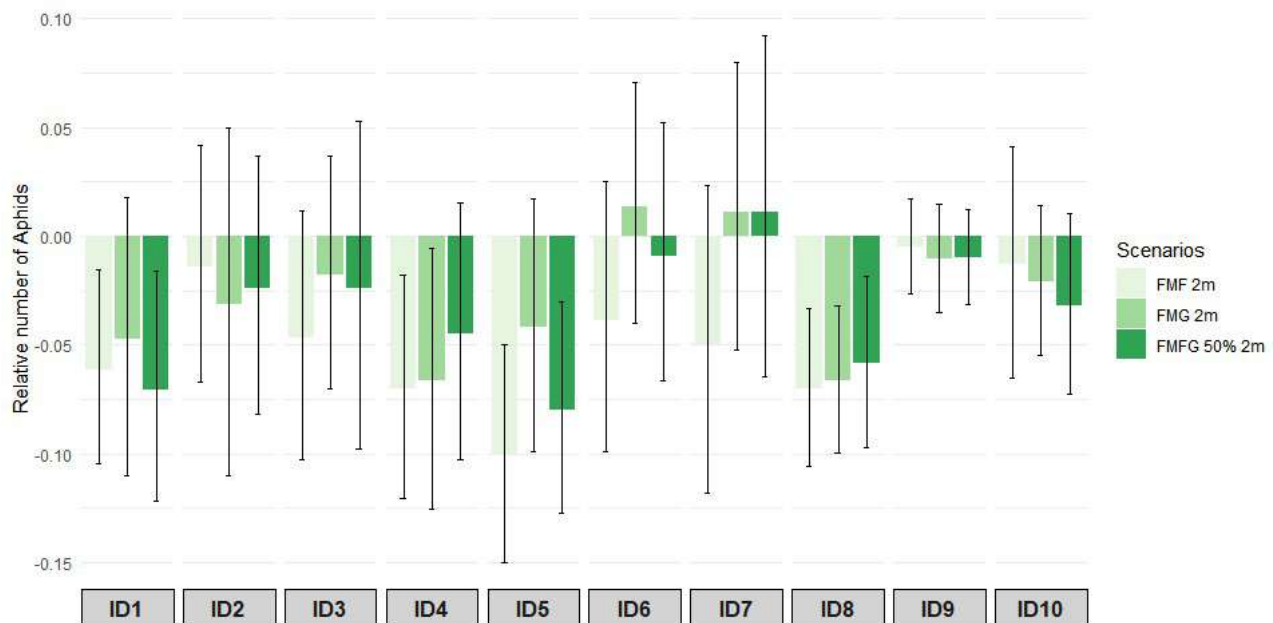


Figure 7.335 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

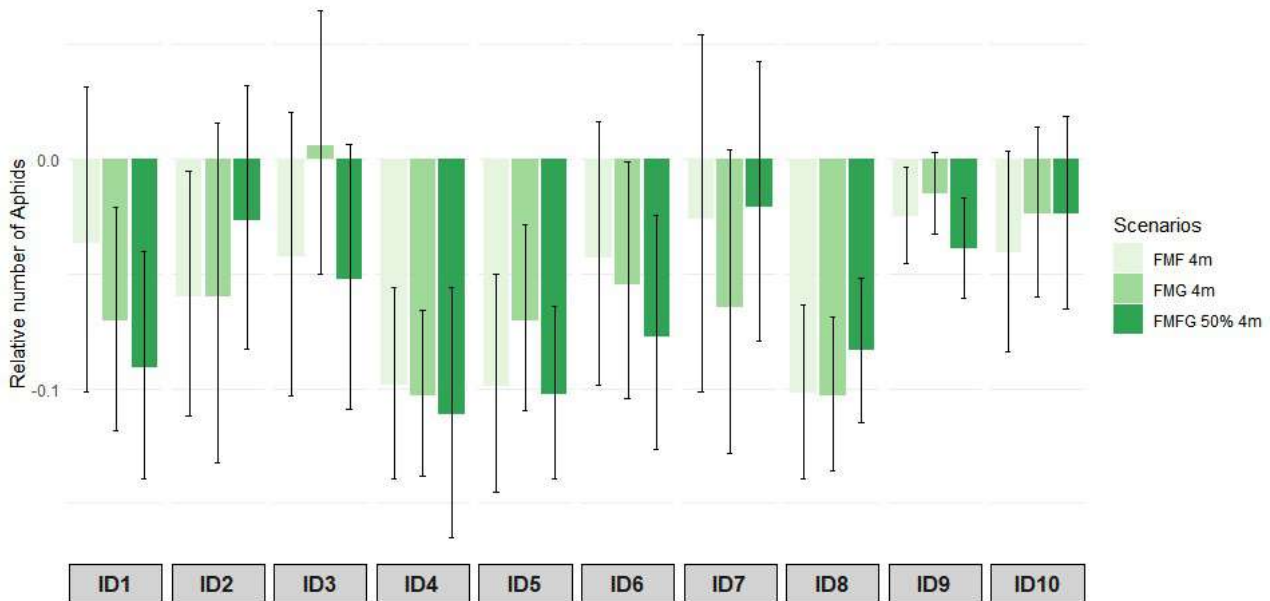


Figure 7.336 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

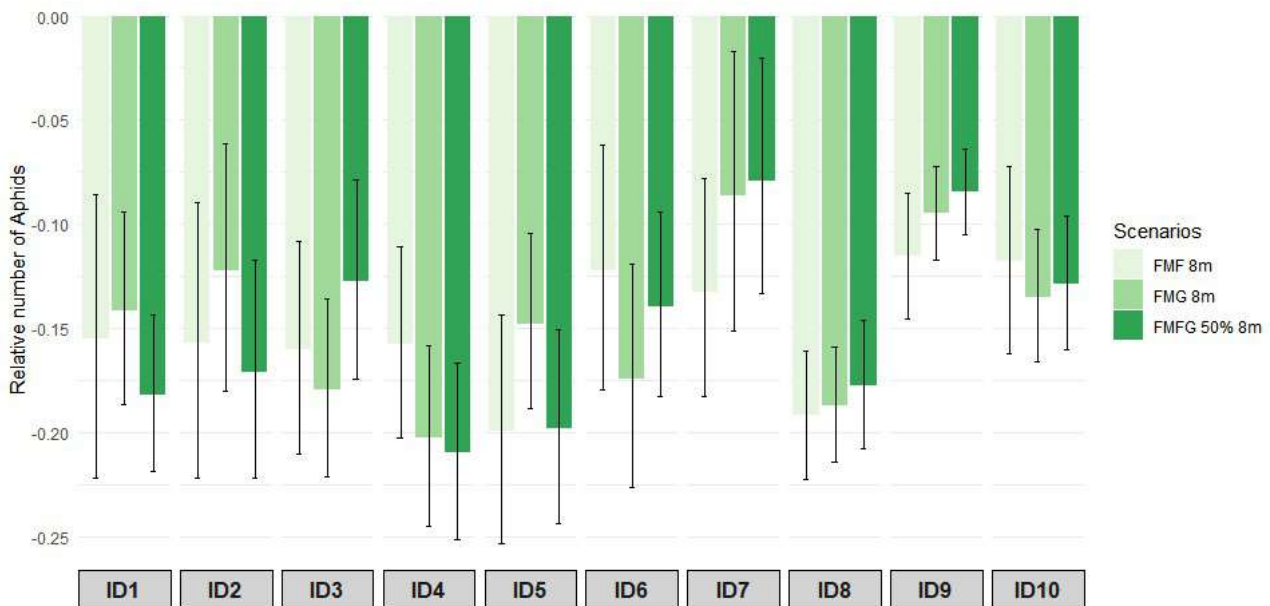


Figure 7.337 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.5.2 In-field

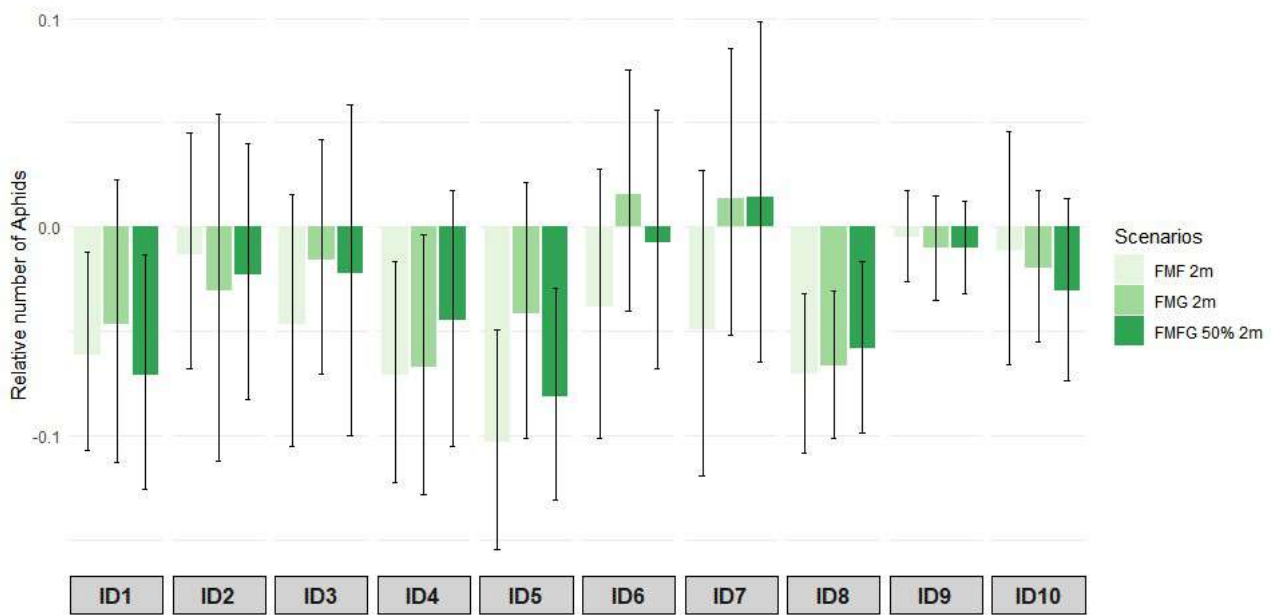


Figure 7.338 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

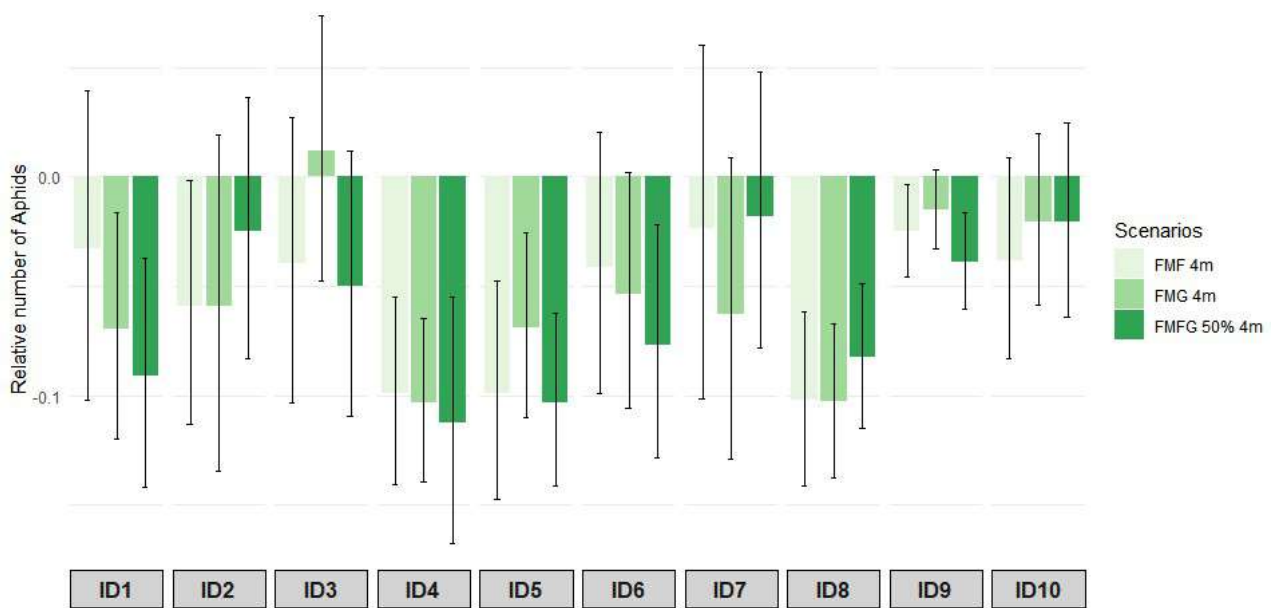


Figure 7.340 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

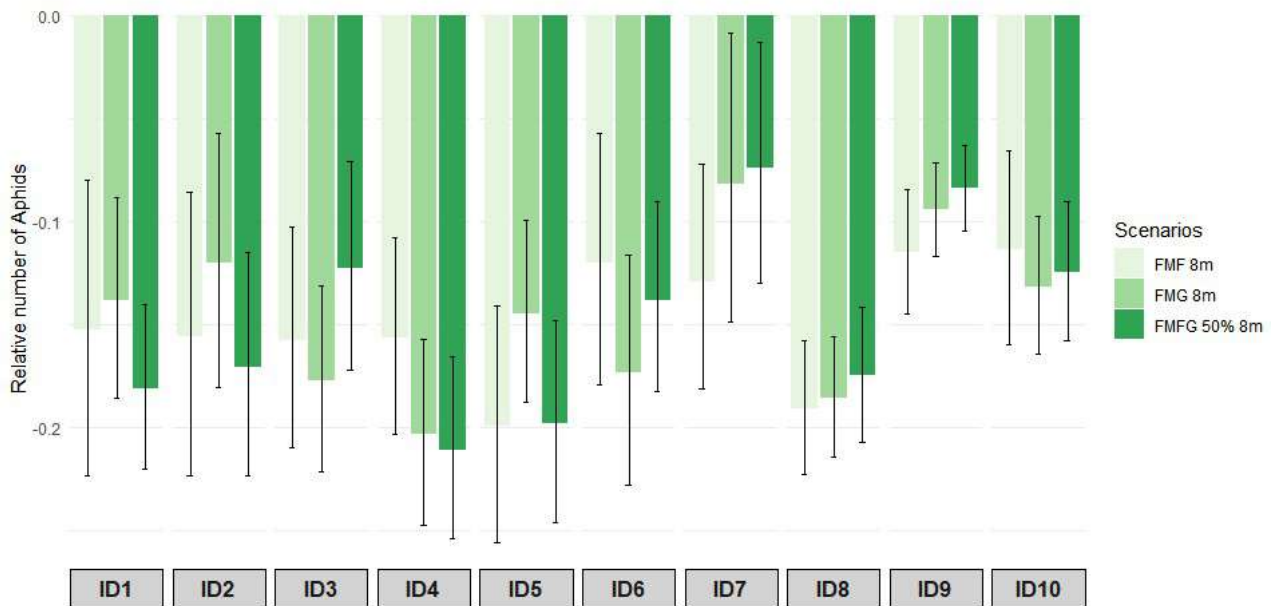


Figure 7.341 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.19.5.3 In-field relative to landscape

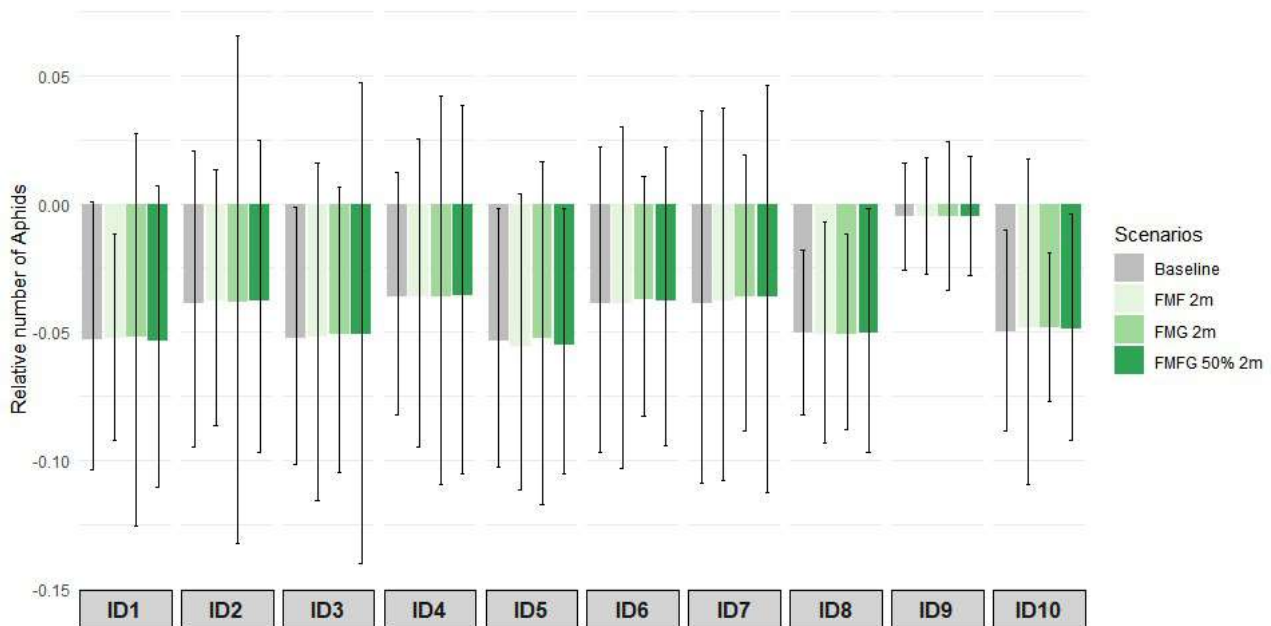


Figure 7.342 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

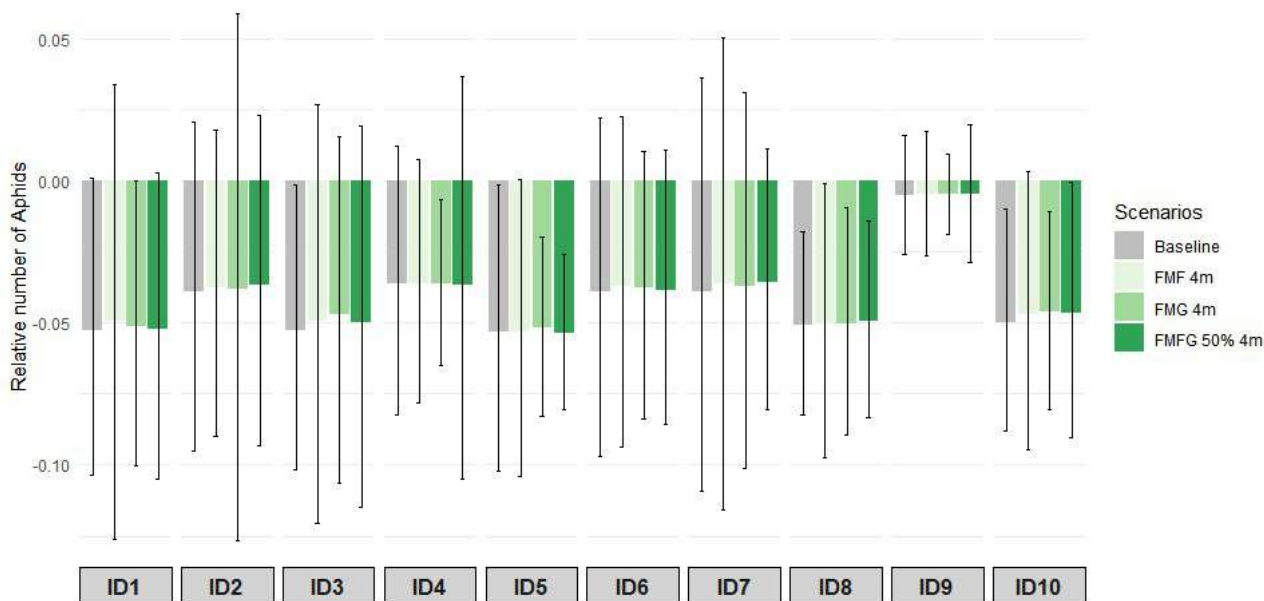


Figure 7.343 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

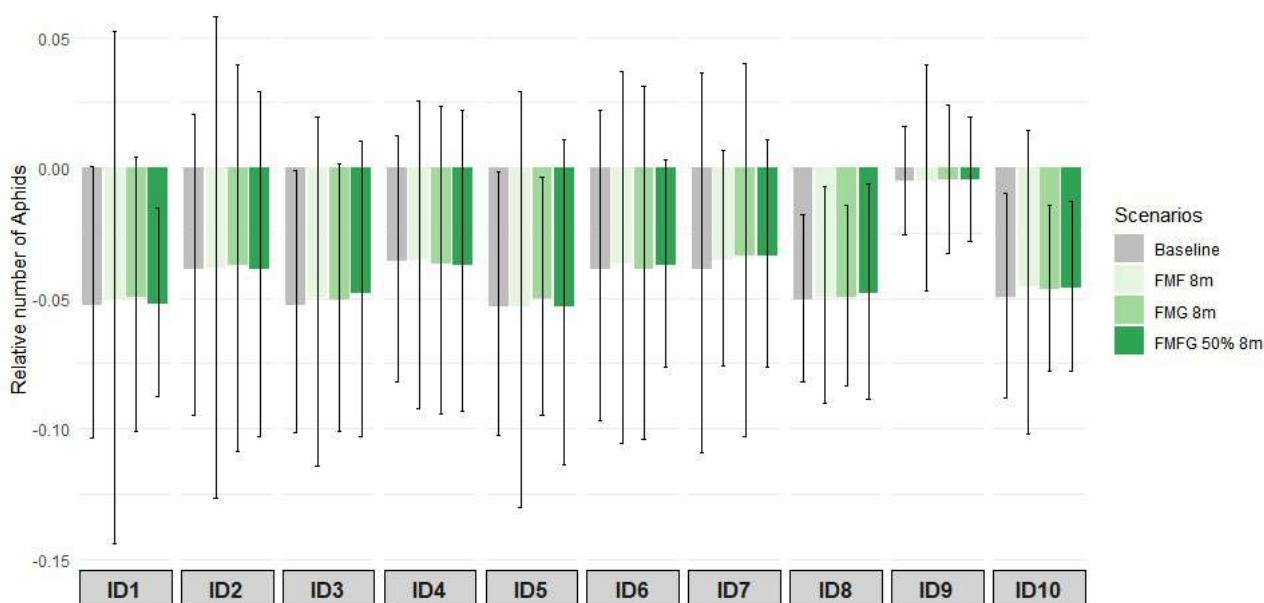


Figure 7.344 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.6 Setaside

7.19.6.1 Whole landscape

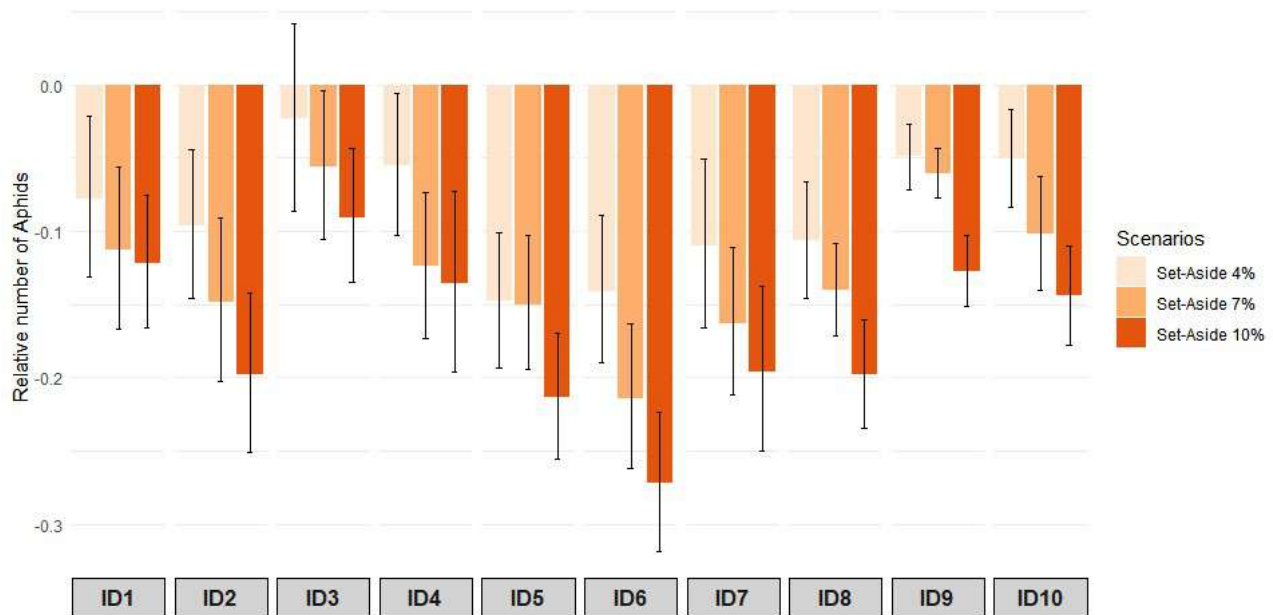


Figure 7.345 Setaside scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.6.2 In-field

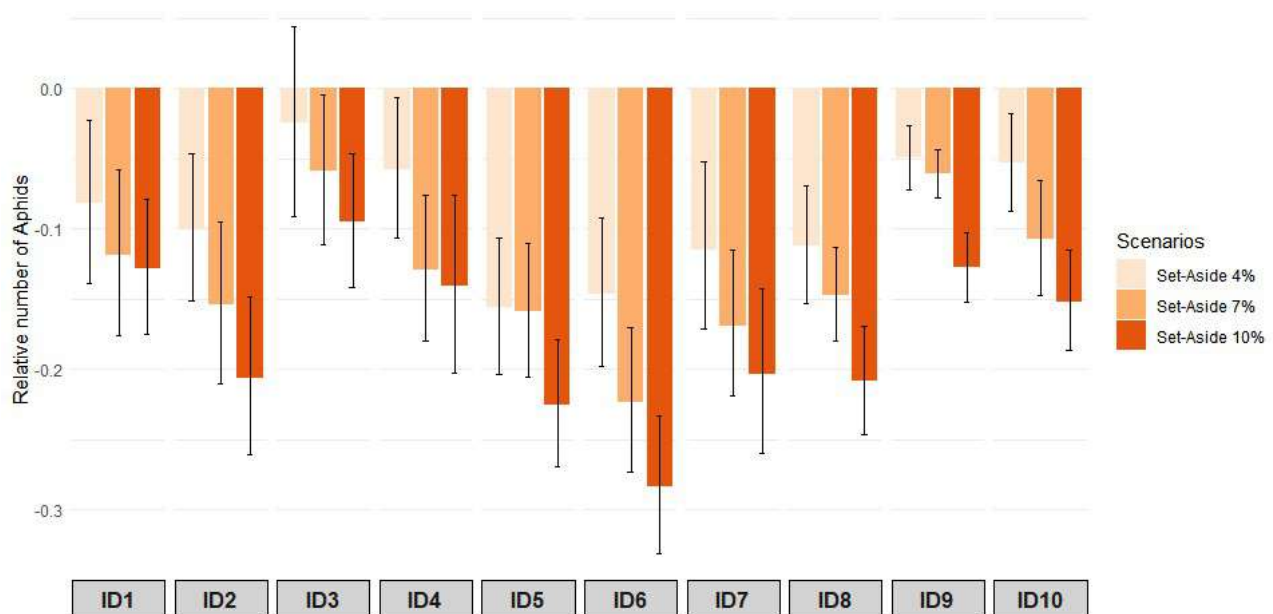


Figure 7.346 Setaside scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark..

7.19.6.3 In-field relative to landscape

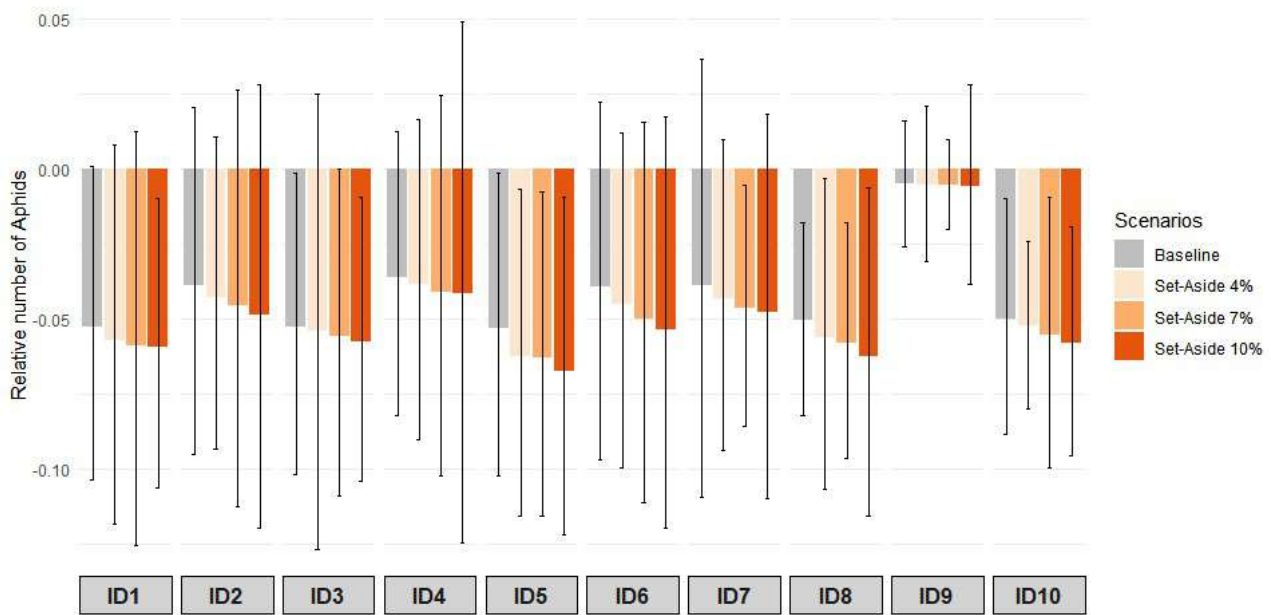


Figure 7.347 Setaside scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.7 Legume

7.19.7.1 Whole landscape

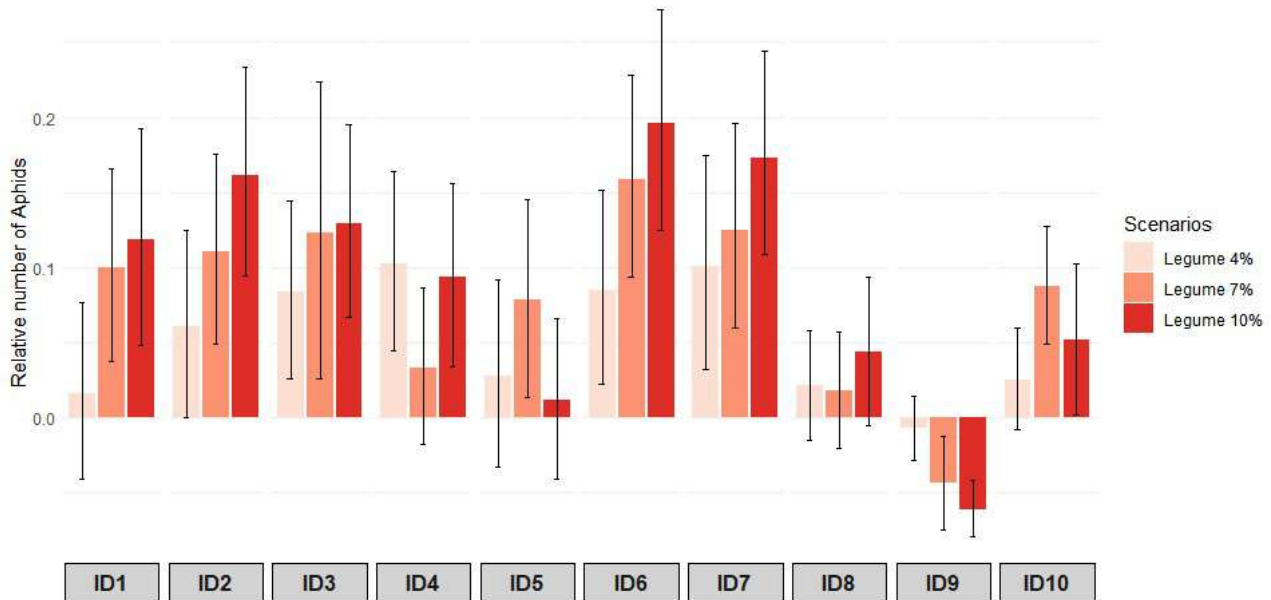


Figure 7.348 Legume scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.7.2 In-field

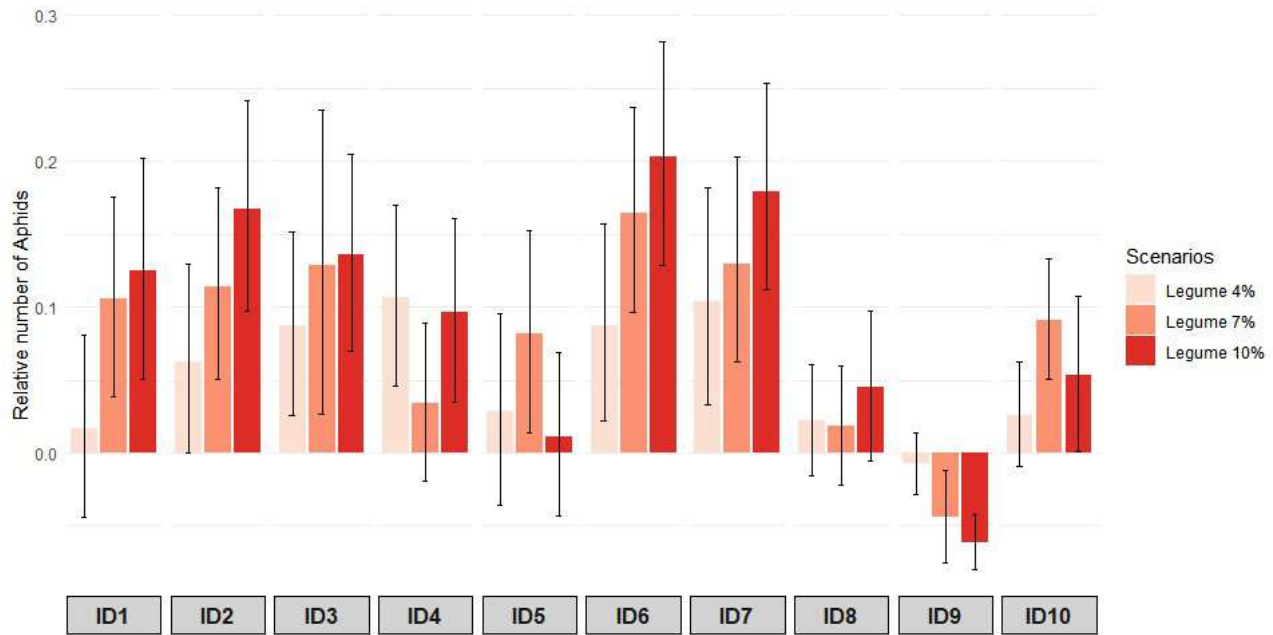


Figure 7.349 Legume scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.19.7.3 In-field relative to landscape

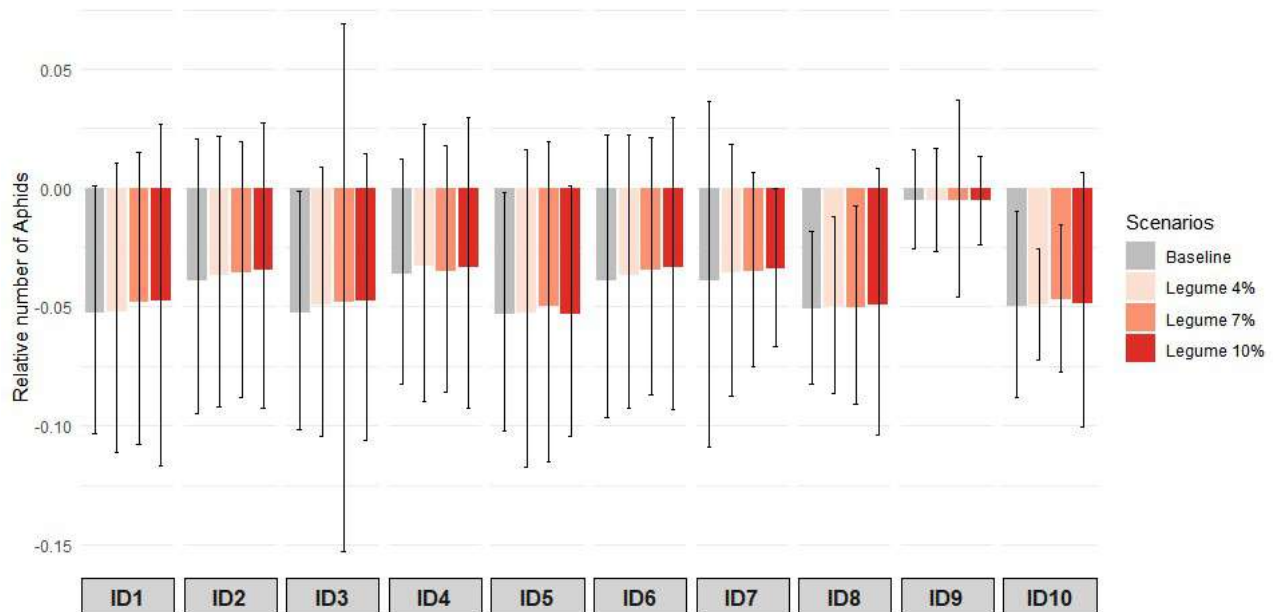


Figure 7.350 Legume scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.19.8 Biopesticides

7.19.8.1 Whole landscape

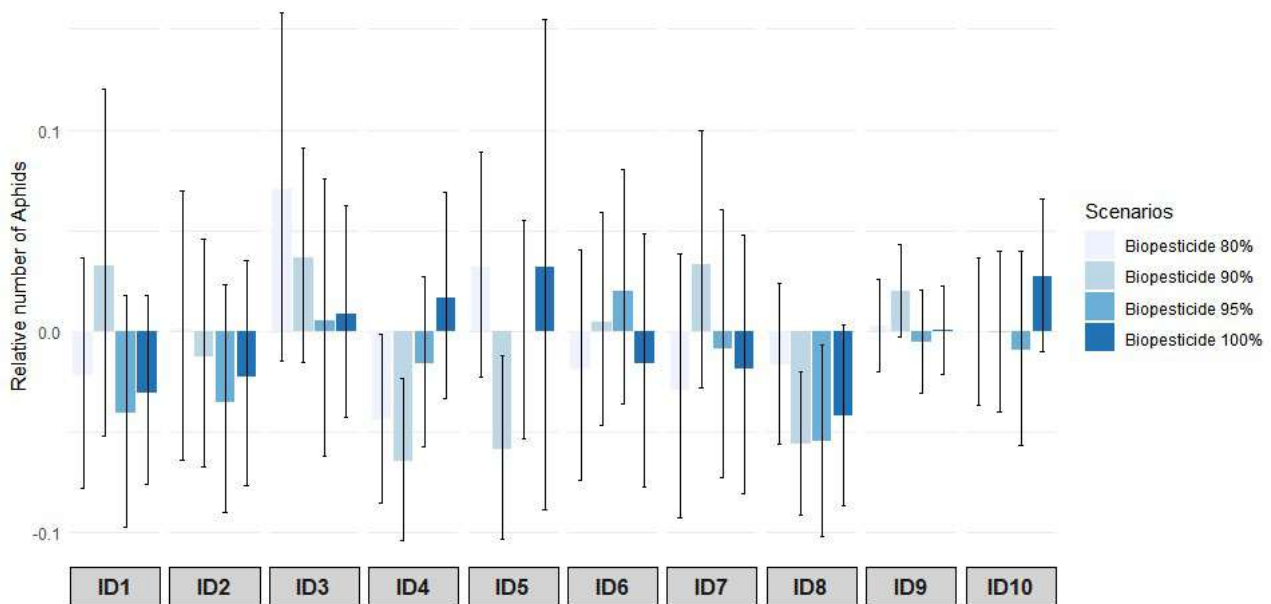


Figure 7.351 Biopesticide scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for each whole landscape in Denmark.

7.19.8.2 In-field

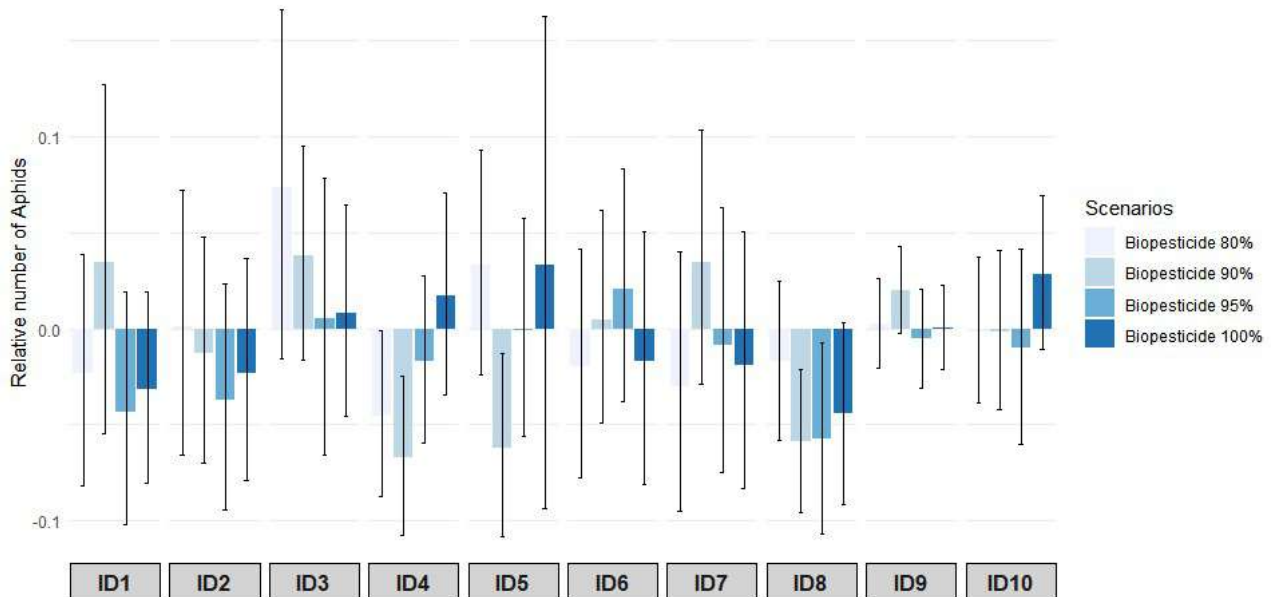


Figure 7.352 Biopesticide scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field area of each landscape in Denmark.

7.19.8.3 In-field relative to landscape

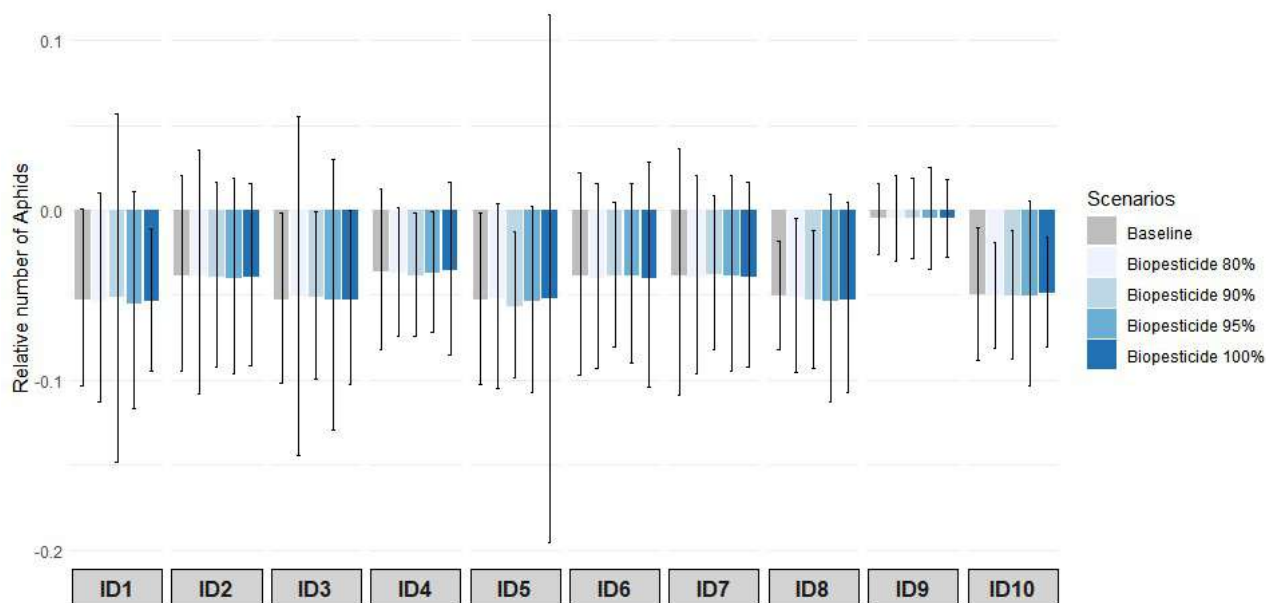


Figure 7.353 Biopesticide scenario with relative change in the number of female aphids in-field compared to whole landscape baseline and standard deviation presented by error bars for each landscape in Denmark.

7.20 Combined landscapes

7.20.1 Crop diversification

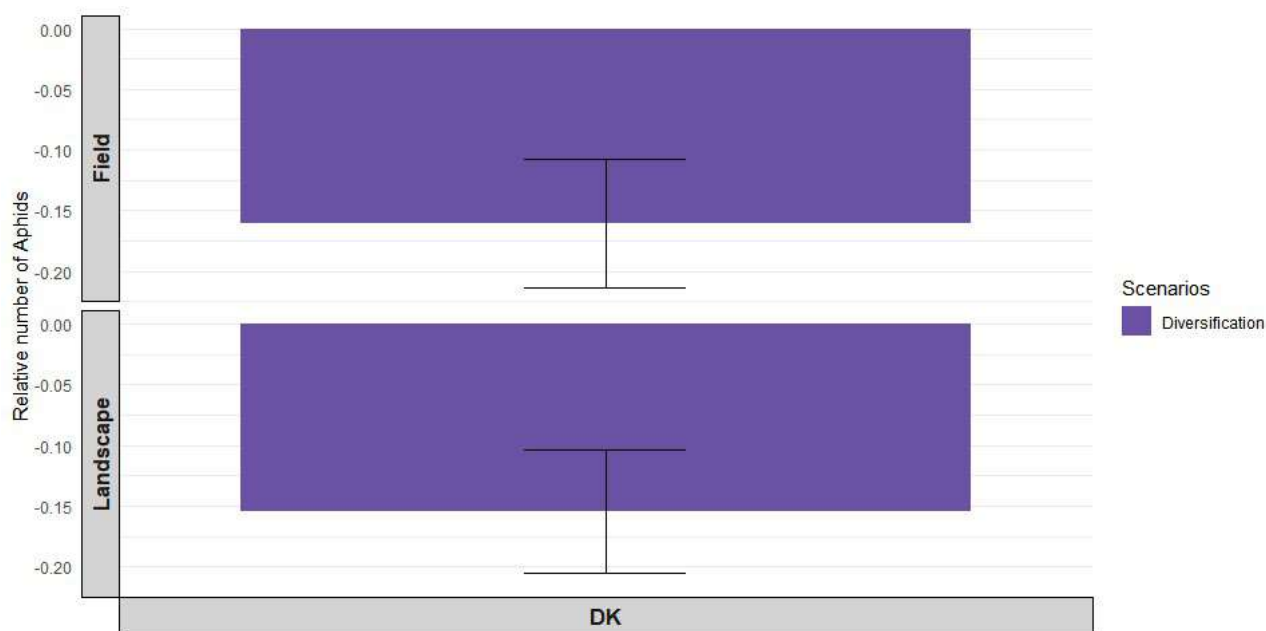


Figure 7.354 Diversification scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Denmark.

7.20.2 Flower field margins

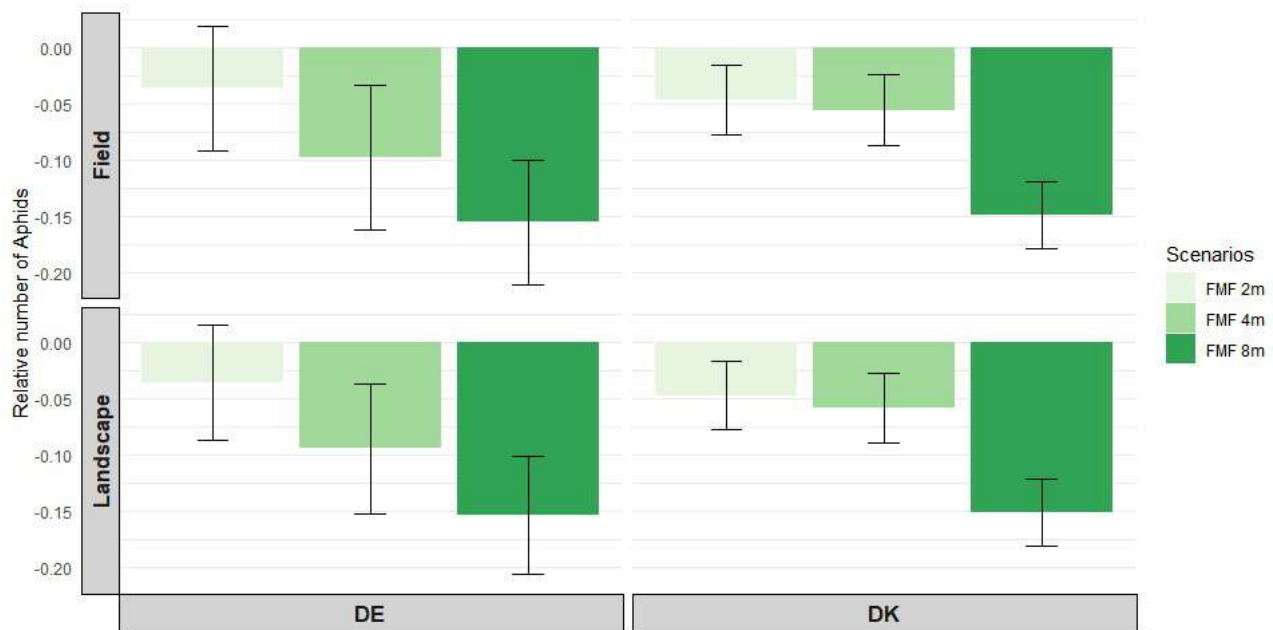


Figure 7.355 Flower field margins with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.3 Grass field margins

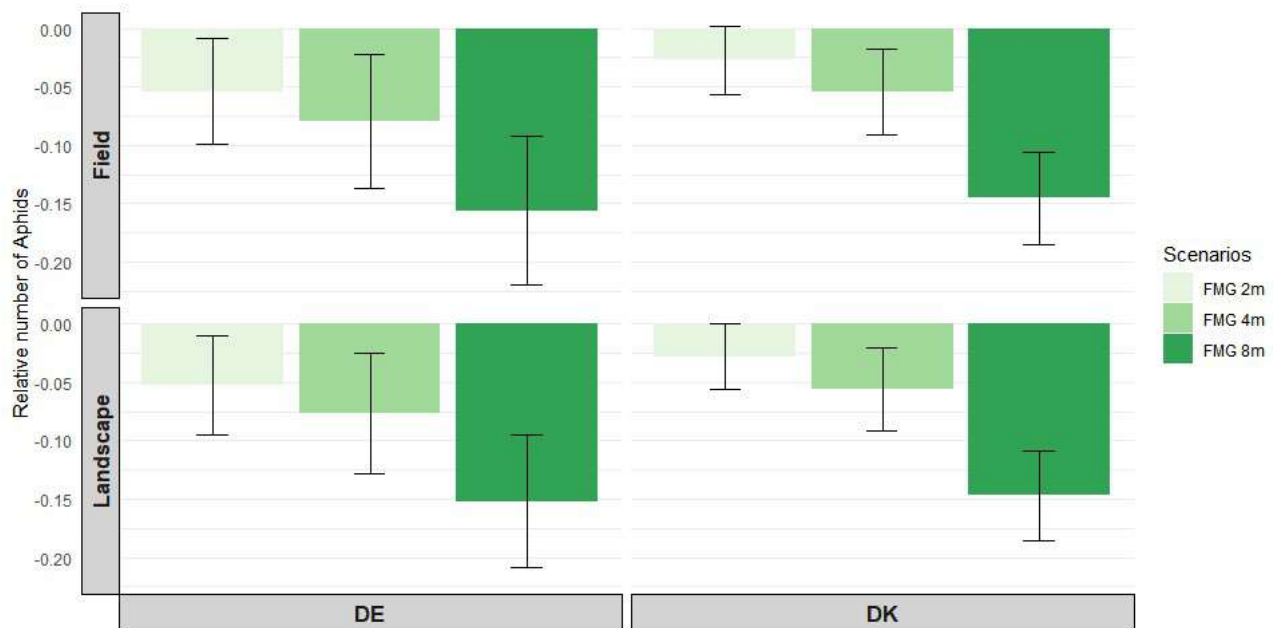


Figure 7.356 Grassy field margins with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.4 Mixed field margins

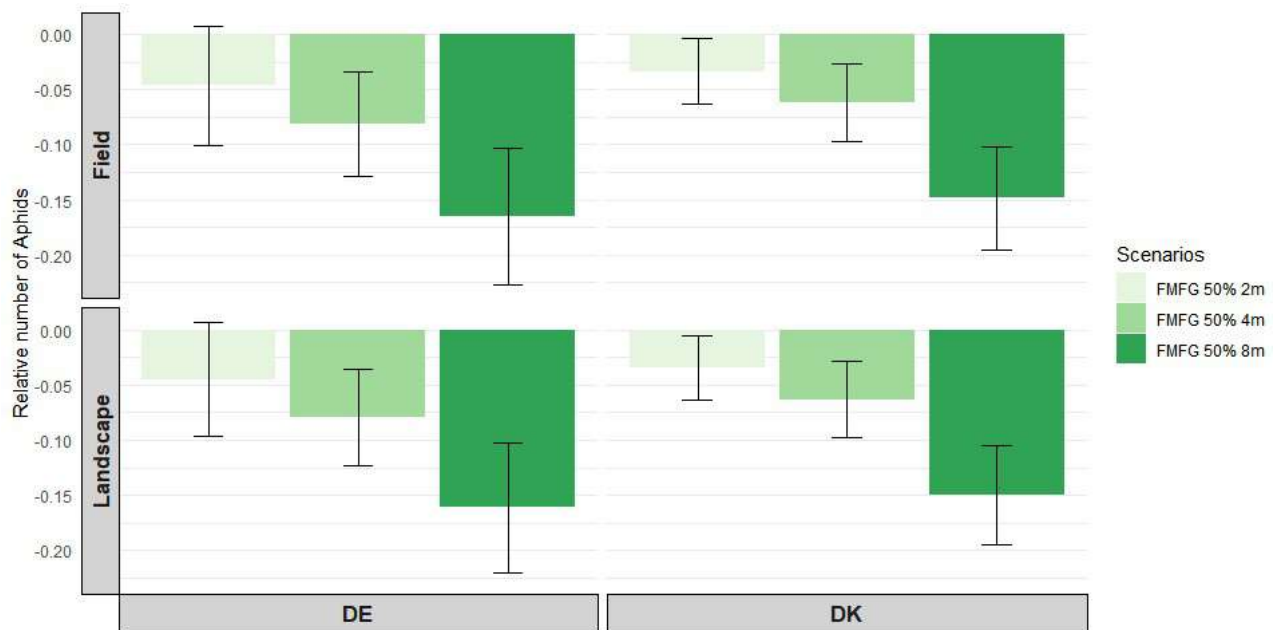


Figure 7.357 Mixed field margins with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.5 Flower, grassy and mixed margins

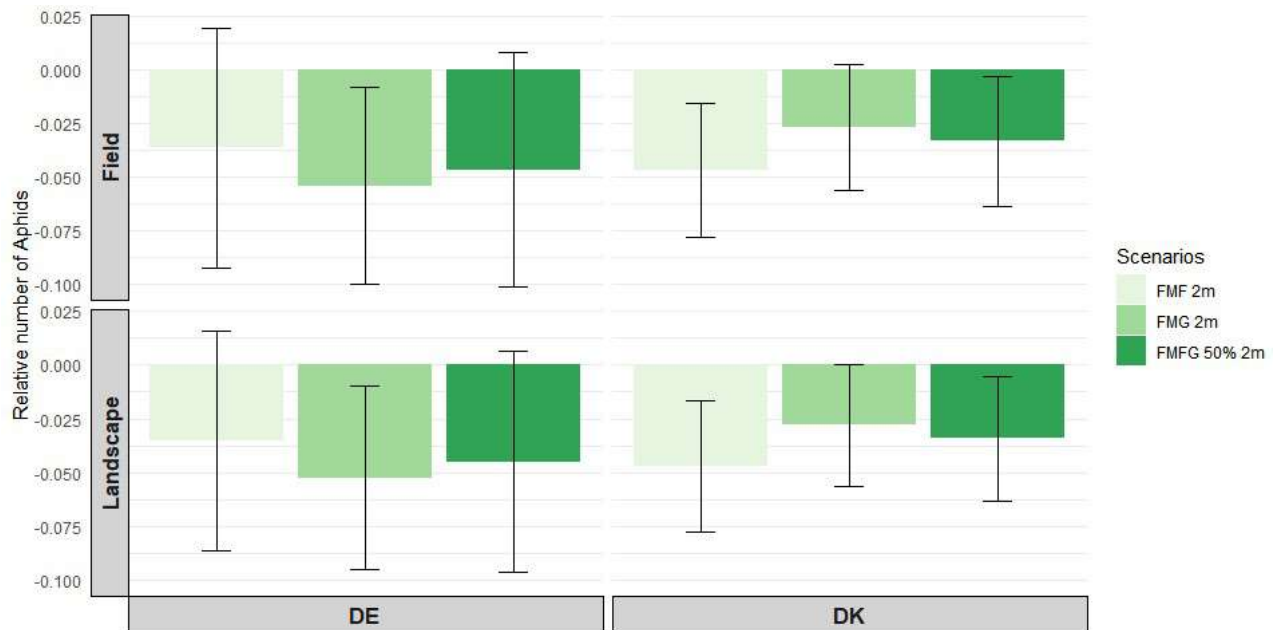


Figure 7.358 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

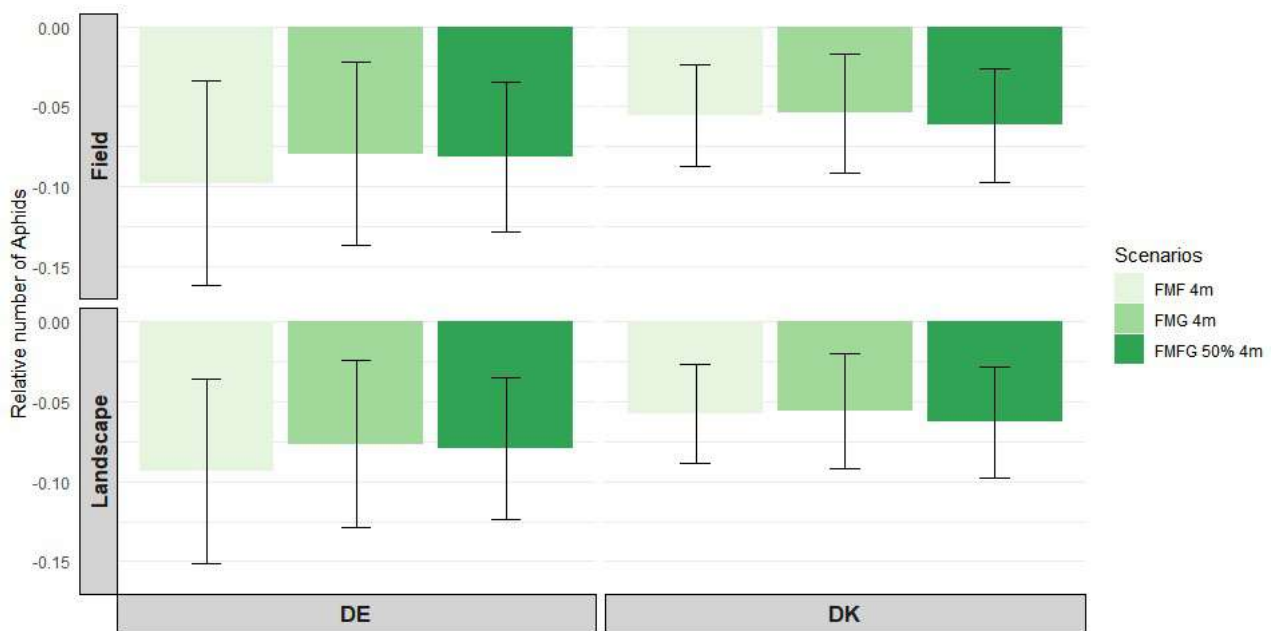


Figure 7.359 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

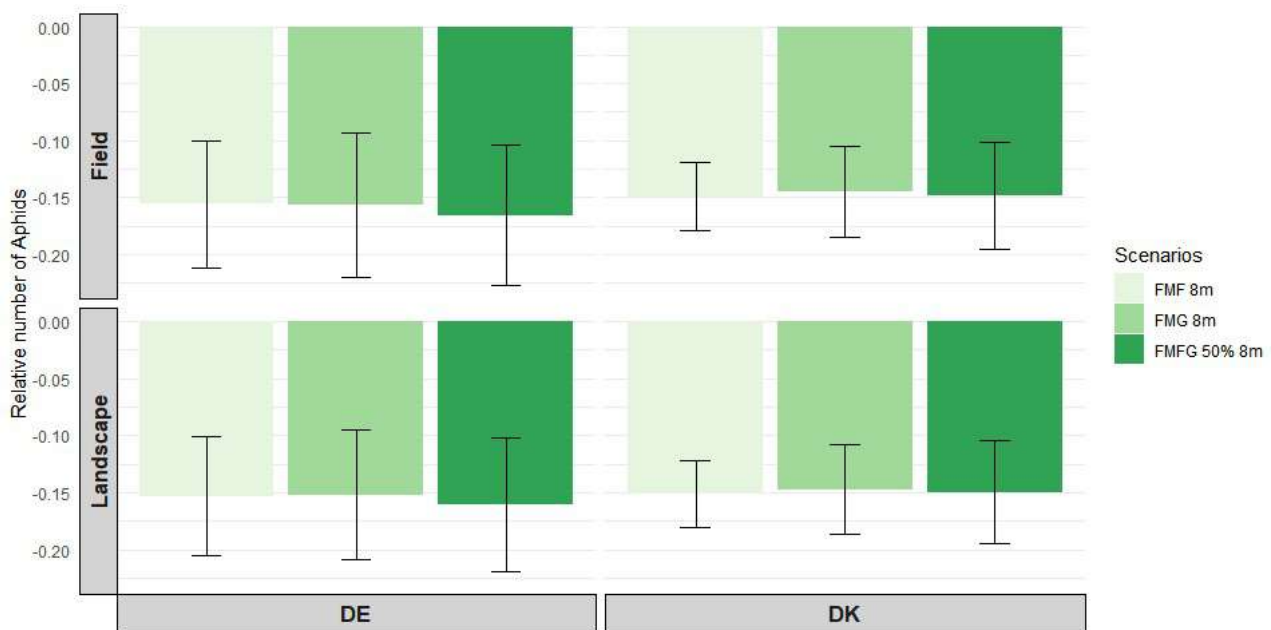


Figure 7.360 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.6 Setaside

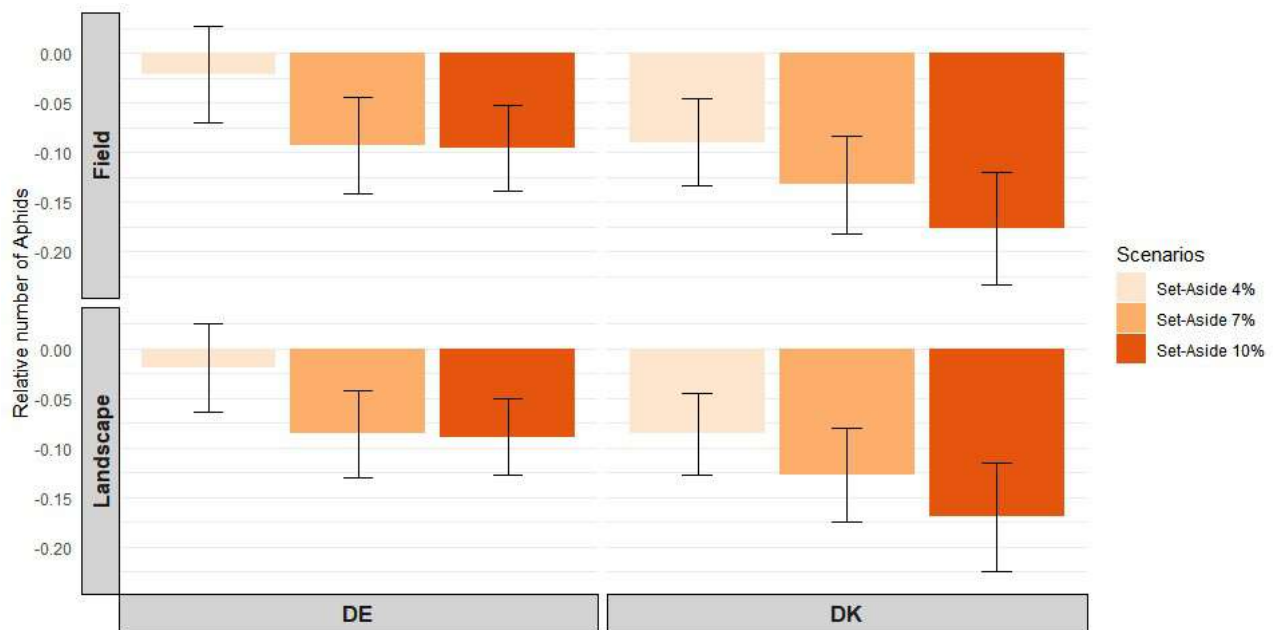


Figure 7.361 Setaside scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.7 Legume

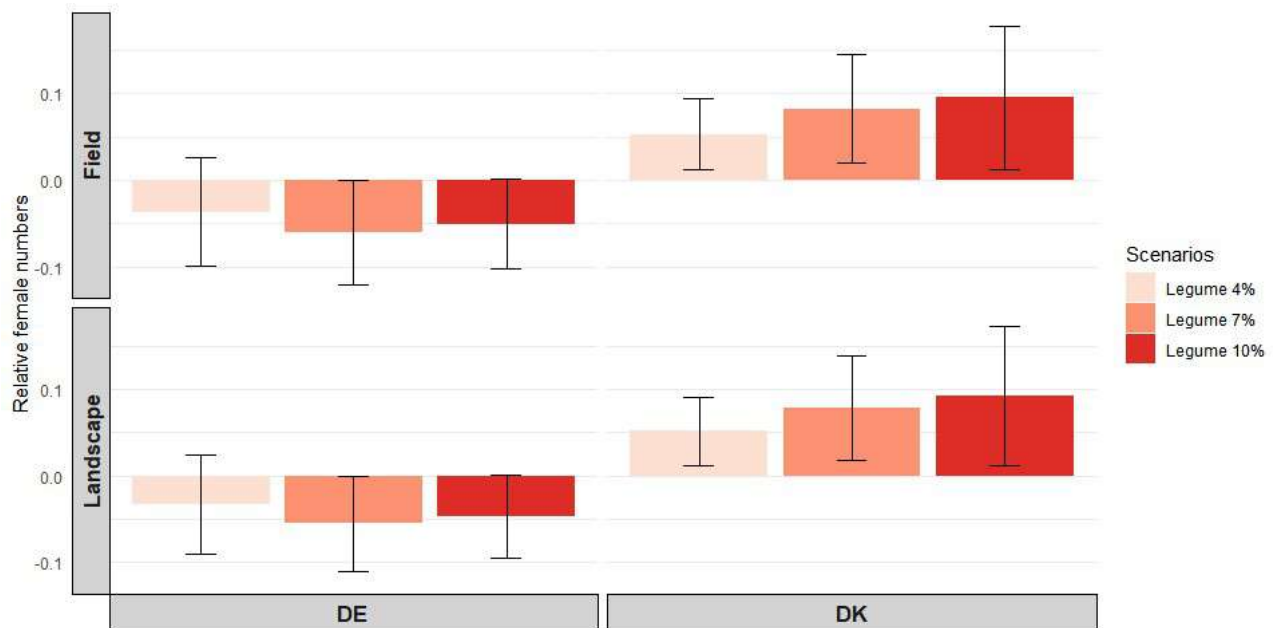


Figure 7.362 Legume scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.8 Biopesticides

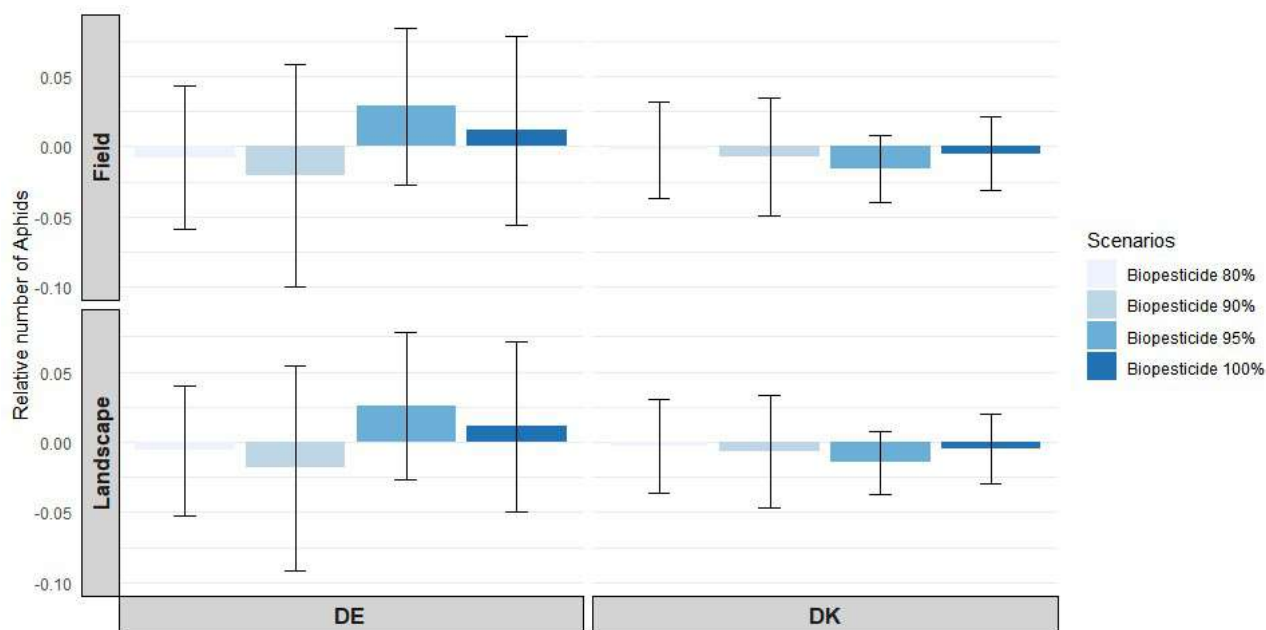


Figure 7.363 Biopesticide scenario with relative change in the number of All female aphids compared to baseline and standard deviation presented by error bars for in-field and whole landscape of Germany and Denmark.

7.20.9 Table of relative change compared to baseline scenarios

Table 7.5 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for All aphids. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scale	Scenario	DK	DE
Field	Diversification	-16% (SD 5%)	NA
Landscape	Diversification	-15% (SD 5%)	NA
Field	FMF 2m	-5% (SD 3%)	-4% (SD 6%)
Field	FMF 4m	-6% (SD 3%)	-10% (SD 6%)
Field	FMF 8m	-15% (SD 3%)	-16% (SD 6%)
Landscape	FMF 2m	-5% (SD 3%)	-4% (SD 5%)
Landscape	FMF 4m	-6% (SD 3%)	-9% (SD 6%)
Landscape	FMF 8m	-15% (SD 3%)	-15% (SD 5%)
Field	FMG 2m	-3% (SD 3%)	-5% (SD 5%)
Field	FMG 4m	-5% (SD 4%)	-8% (SD 6%)
Field	FMG 8m	-15% (SD 4%)	-16% (SD 6%)
Landscape	FMG 2m	-3% (SD 3%)	-5% (SD 4%)

Scale	Scenario	DK	DE
Landscape	FMG 4m	-6% (SD 4%)	-8% (SD 5%)
Landscape	FMG 8m	-15% (SD 4%)	-15% (SD 6%)
Field	FMFG 50% 2m	-3% (SD 3%)	-5% (SD 5%)
Field	FMFG 50% 4m	-6% (SD 4%)	-8% (SD 5%)
Field	FMFG 50% 8m	-15% (SD 5%)	-17% (SD 6%)
Landscape	FMFG 50% 2m	-3% (SD 3%)	-4% (SD 5%)
Landscape	FMFG 50% 4m	-6% (SD 3%)	-8% (SD 4%)
Landscape	FMFG 50% 8m	-15% (SD 5%)	-16% (SD 6%)
Field	Set-Aside 4%	-9% (SD 4%)	-2% (SD 5%)
Field	Set-Aside 7%	-13% (SD 5%)	-9% (SD 5%)
Field	Set-Aside 10%	-18% (SD 6%)	-10% (SD 4%)
Landscape	Set-Aside 4%	-9% (SD 4%)	-2% (SD 5%)
Landscape	Set-Aside 7%	-13% (SD 5%)	-9% (SD 4%)
Landscape	Set-Aside 10%	-17% (SD 5%)	-9% (SD 4%)
Field	Legume 4%	5% (SD 4%)	-4% (SD 6%)
Field	Legume 7%	8% (SD 6%)	-6% (SD 6%)
Field	Legume 10%	10% (SD 8%)	-5% (SD 5%)
Landscape	Legume 4%	5% (SD 4%)	-3% (SD 6%)
Landscape	Legume 7%	8% (SD 6%)	-6% (SD 5%)
Landscape	Legume 10%	9% (SD 8%)	-5% (SD 5%)
Field	Biopesticide 80%	-0% (SD 3%)	-1% (SD 5%)
Field	Biopesticide 90%	-1% (SD 4%)	-2% (SD 8%)
Field	Biopesticide 95%	-2% (SD 2%)	3% (SD 6%)
Field	Biopesticide 100%	-0% (SD 3%)	1% (SD 7%)
Landscape	Biopesticide 80%	-0% (SD 3%)	-1% (SD 5%)
Landscape	Biopesticide 90%	-1% (SD 4%)	-2% (SD 7%)
Landscape	Biopesticide 95%	-1% (SD 2%)	3% (SD 5%)
Landscape	Biopesticide 100%	-0% (SD 3%)	1% (SD 6%)

8 HARE

8.1 Baselines

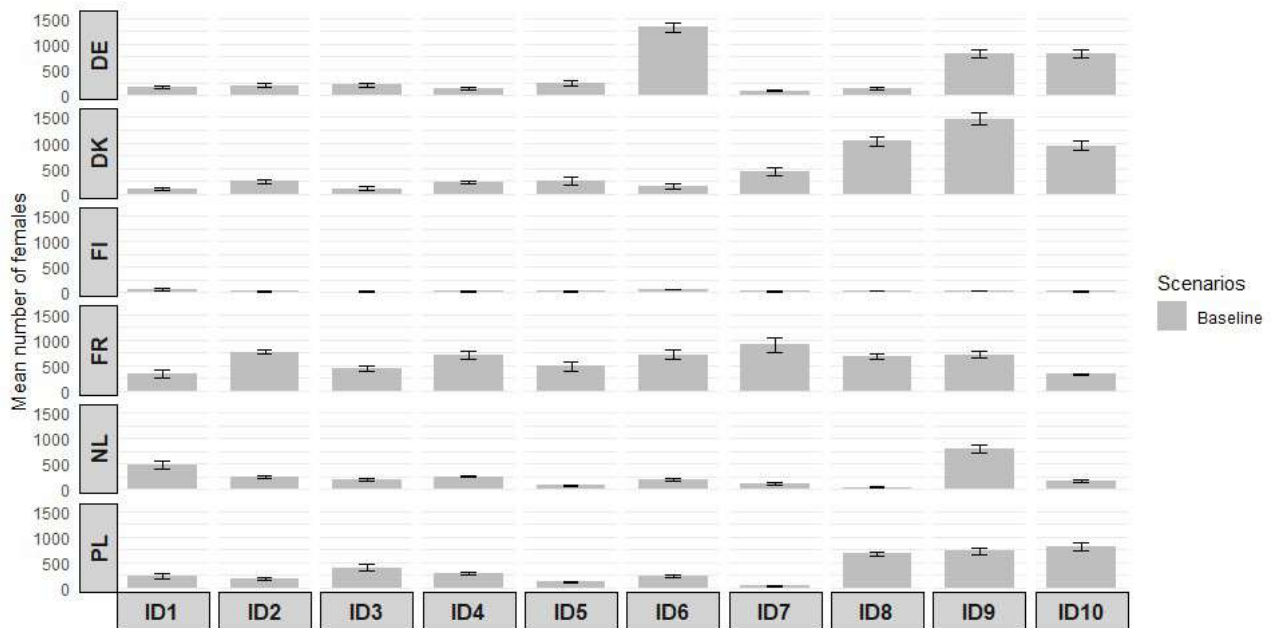


Figure 8.1 Hare baselines for each country and landscape.

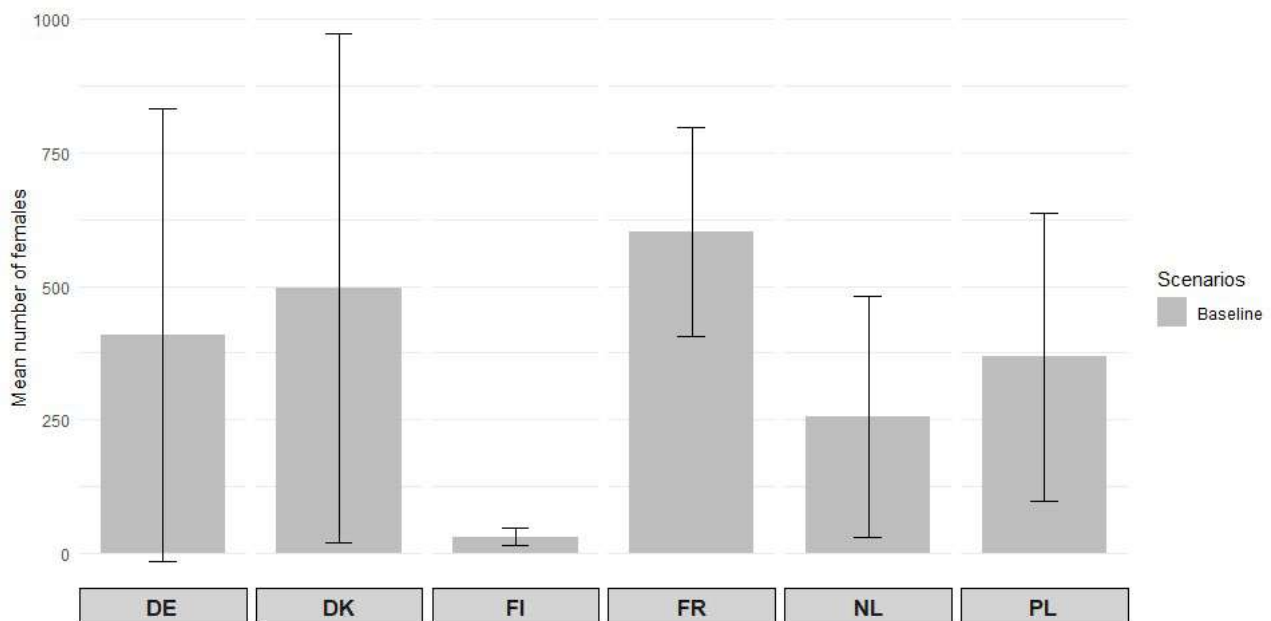


Figure 8.2 Hare baselines for each country combined across landscapes.

8.2 Germany

8.2.1 Crop diversification

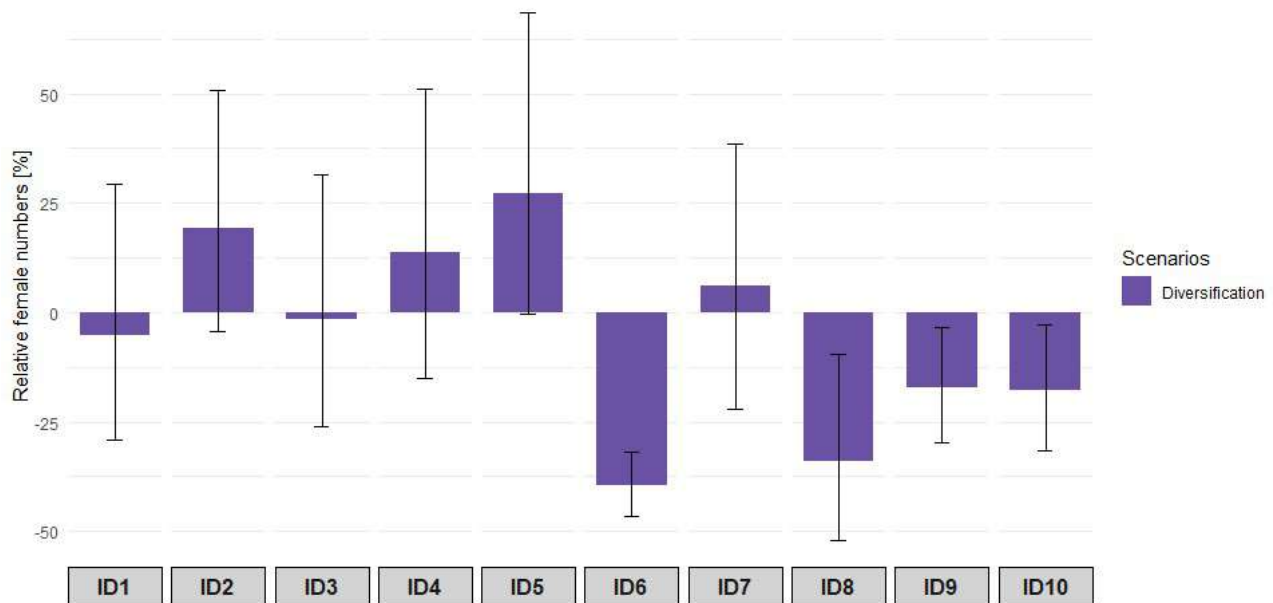


Figure 8.3 Diversification scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

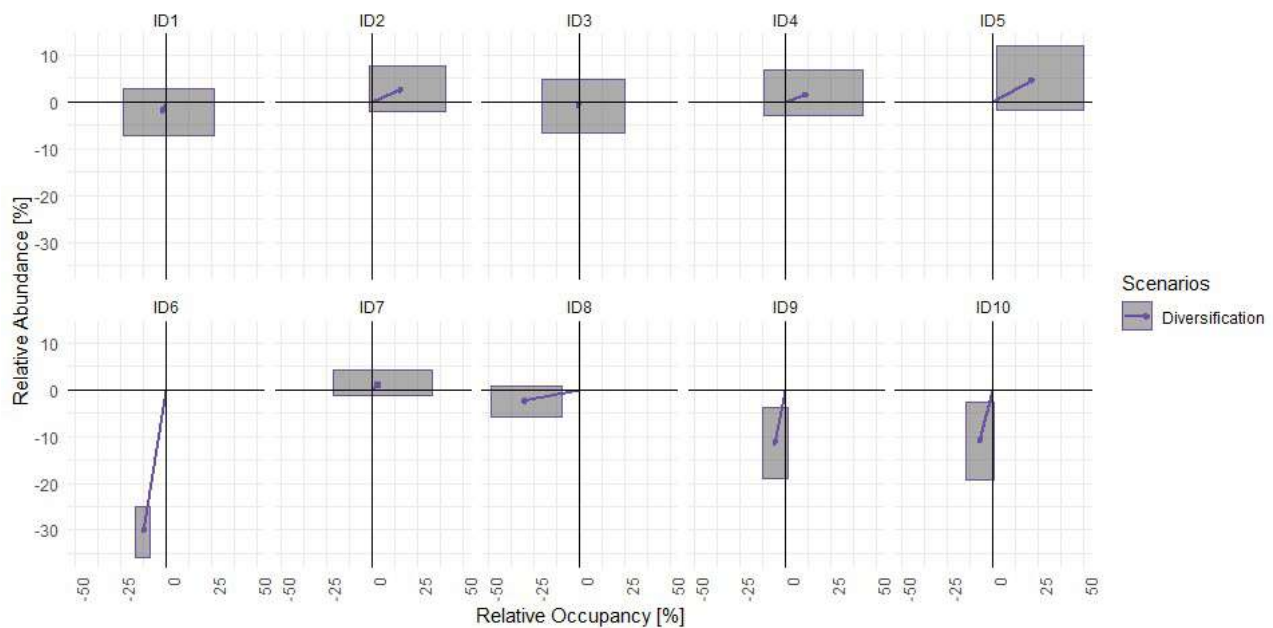


Figure 8.4 Diversification scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.2 Flower field margins

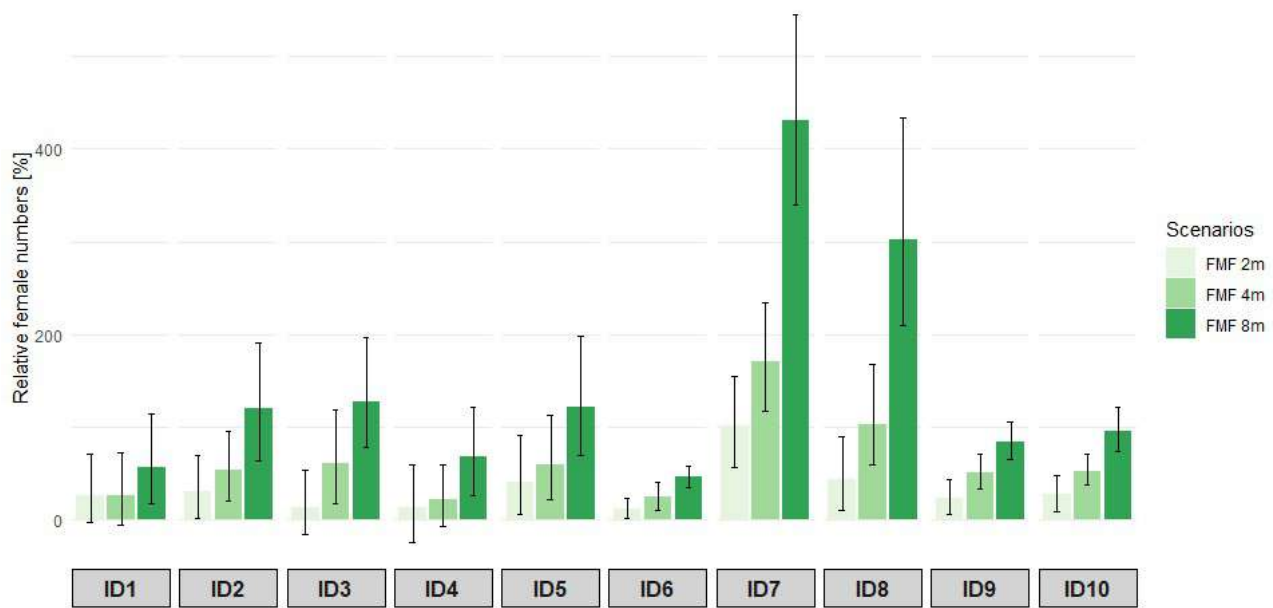


Figure 8.5 Flower field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

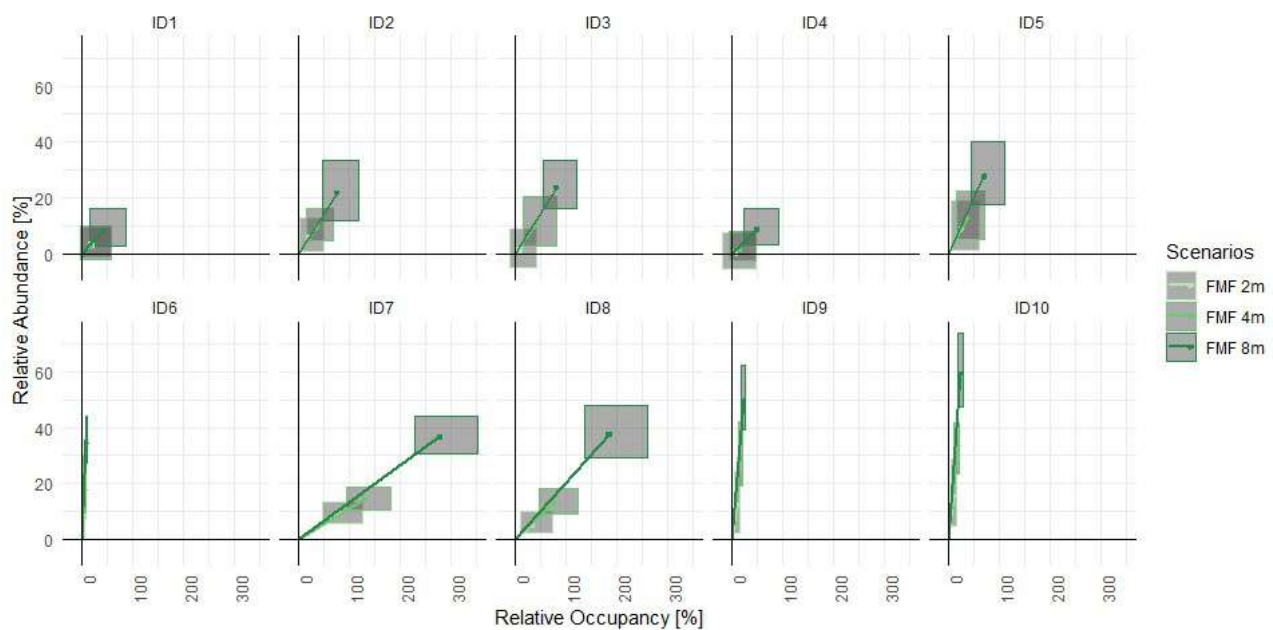


Figure 8.6 Flower field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.3 Grassy field margins

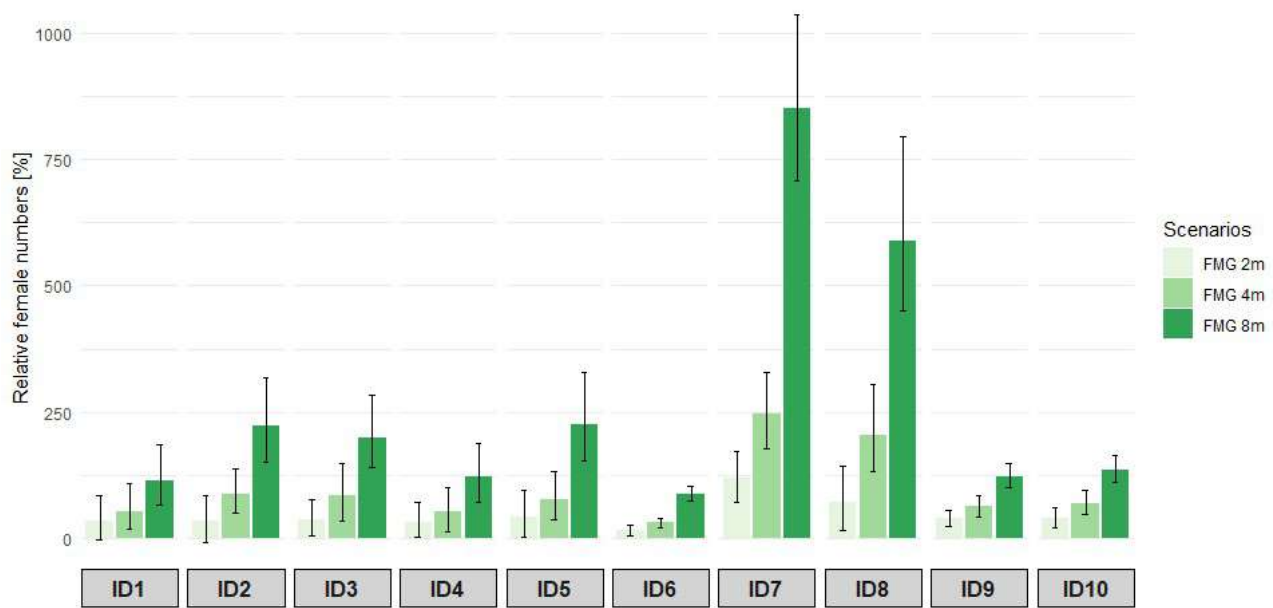


Figure 8.7 Grassy field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

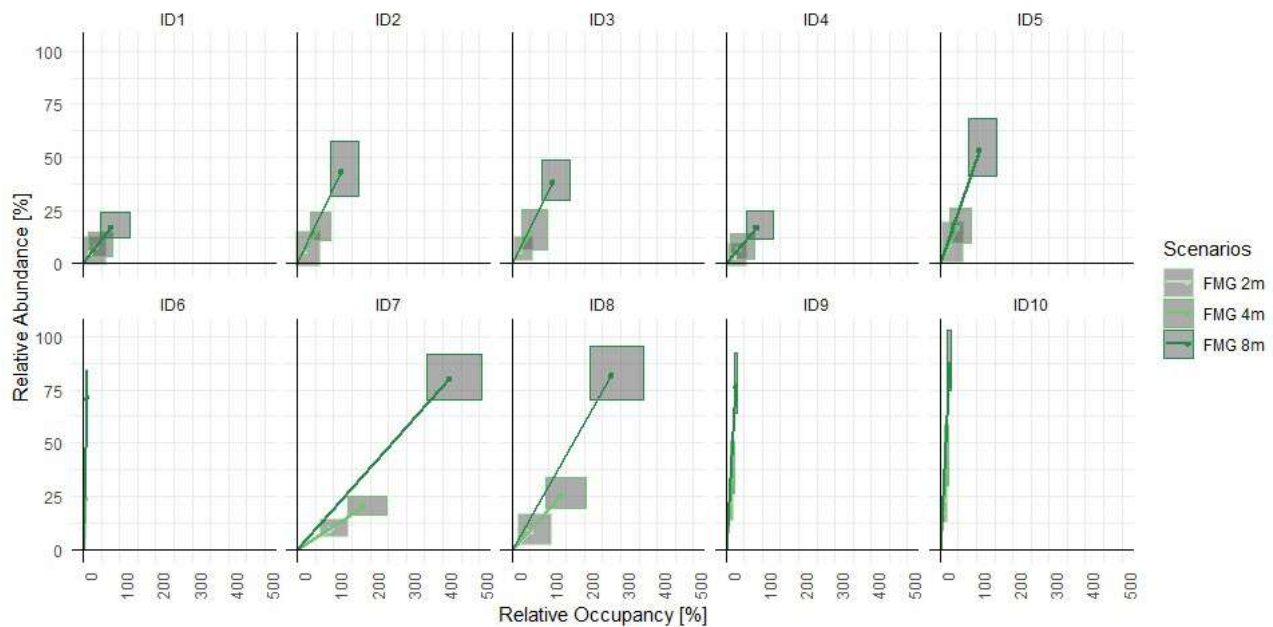


Figure 8.8 Grassy field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.4 Mixed field margins

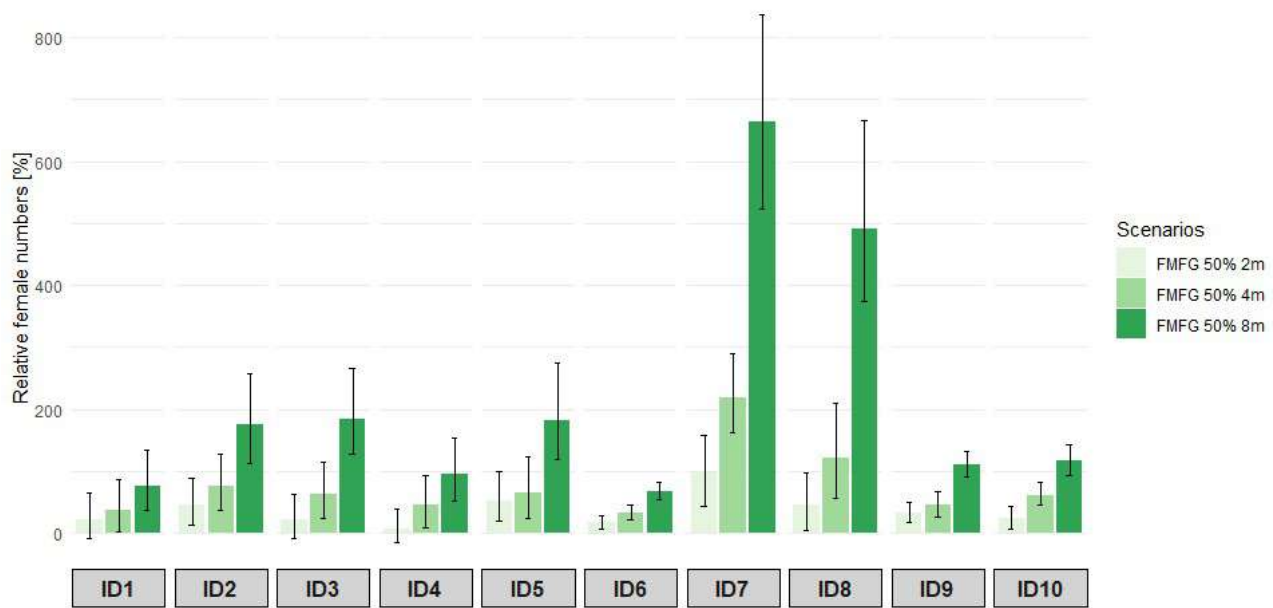


Figure 8.9 Mixed field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

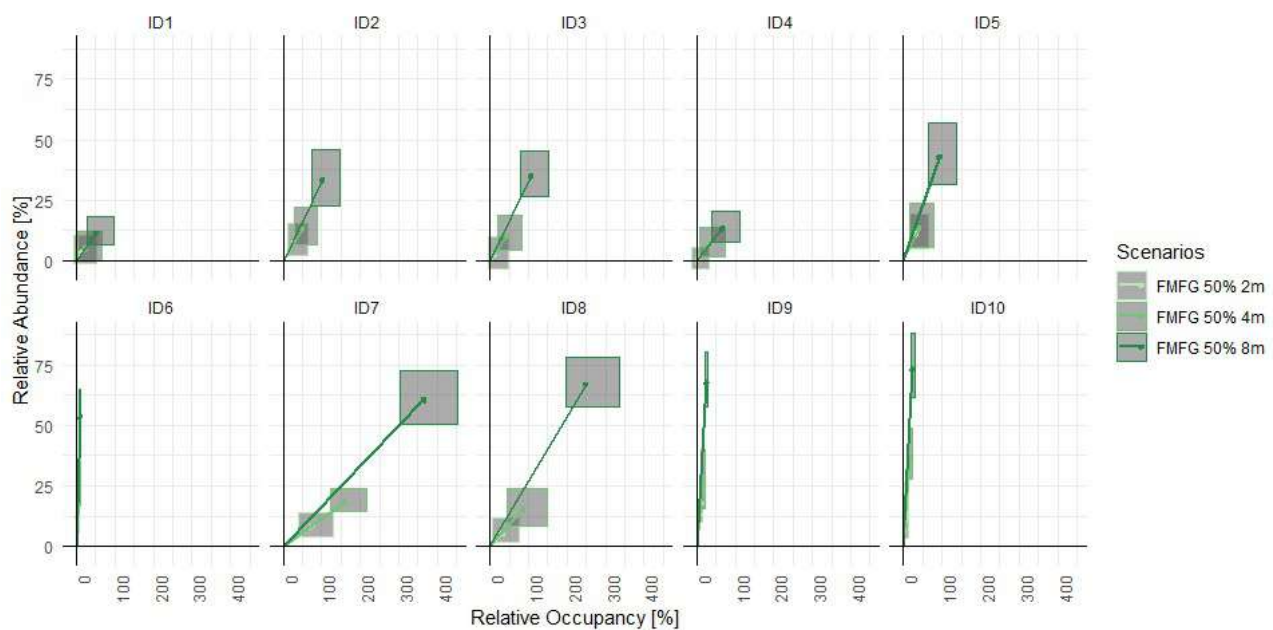


Figure 8.10 Mixed field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.5 Flower, grassy and mixed field margins

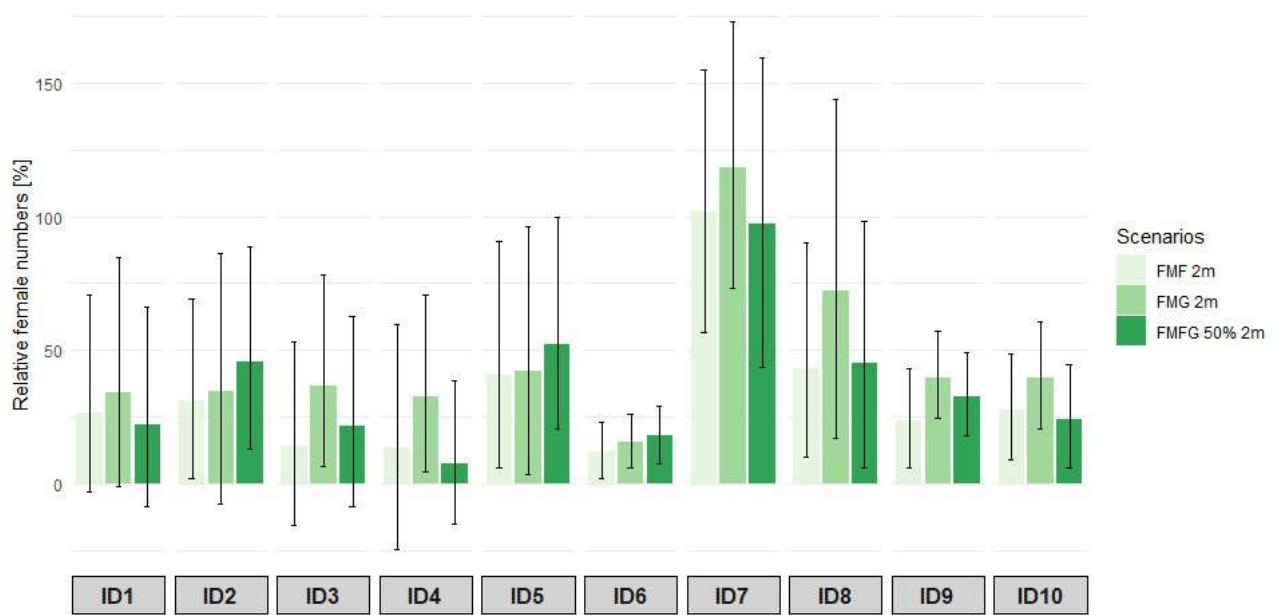


Figure 8.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

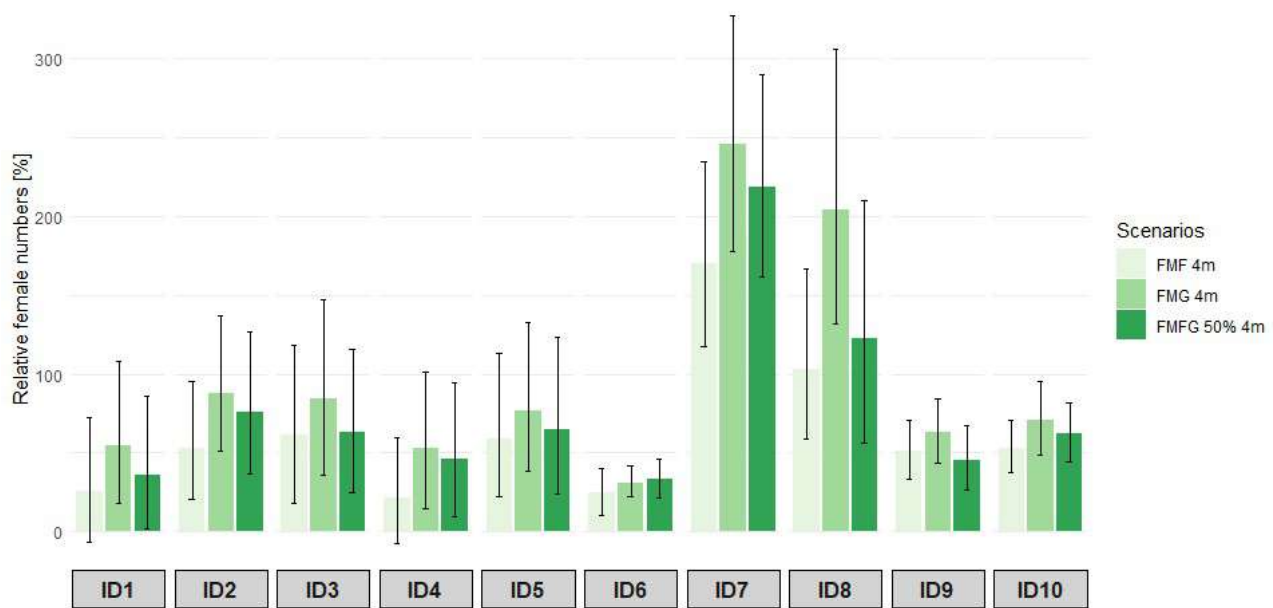


Figure 8.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

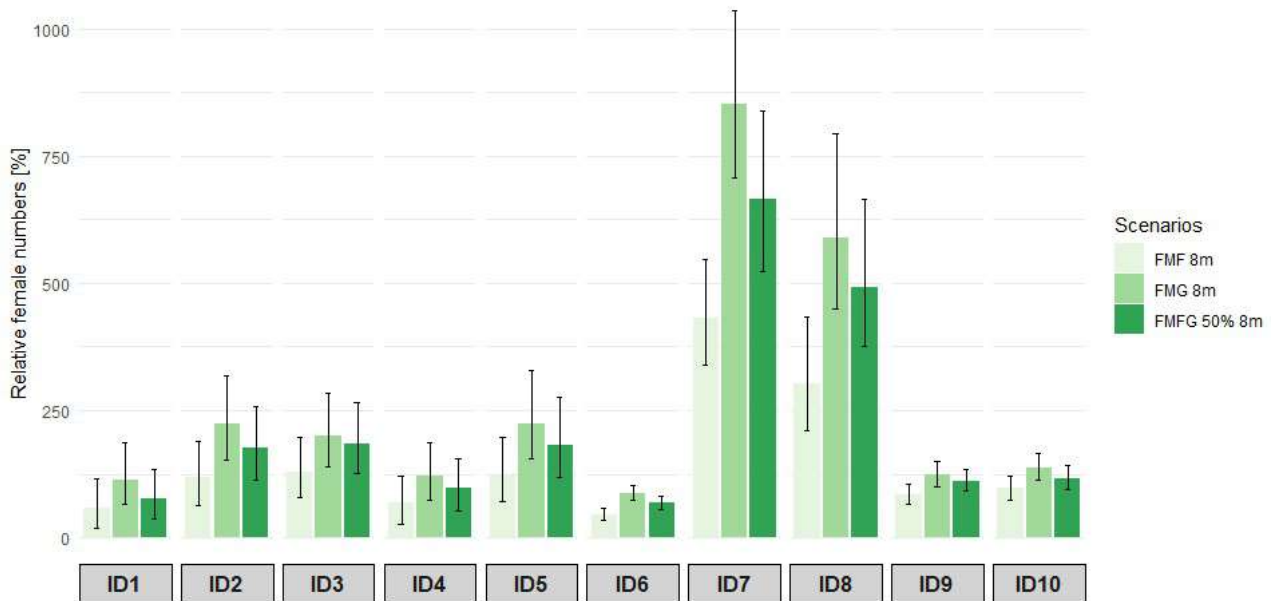


Figure 8.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

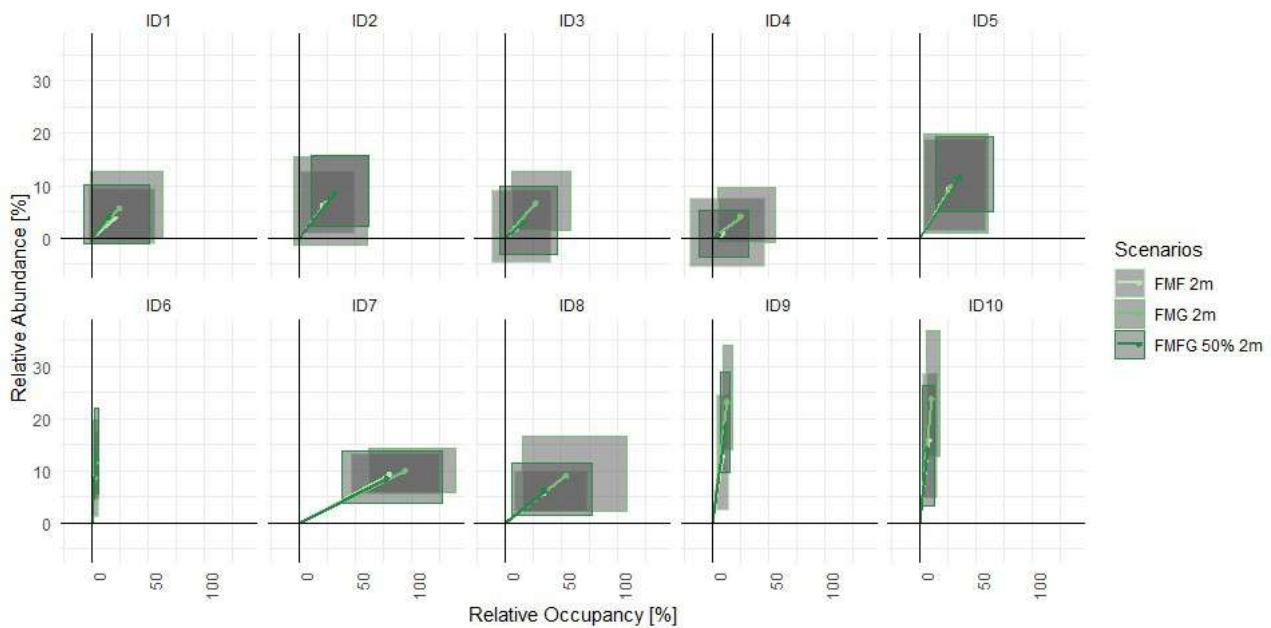


Figure 8.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

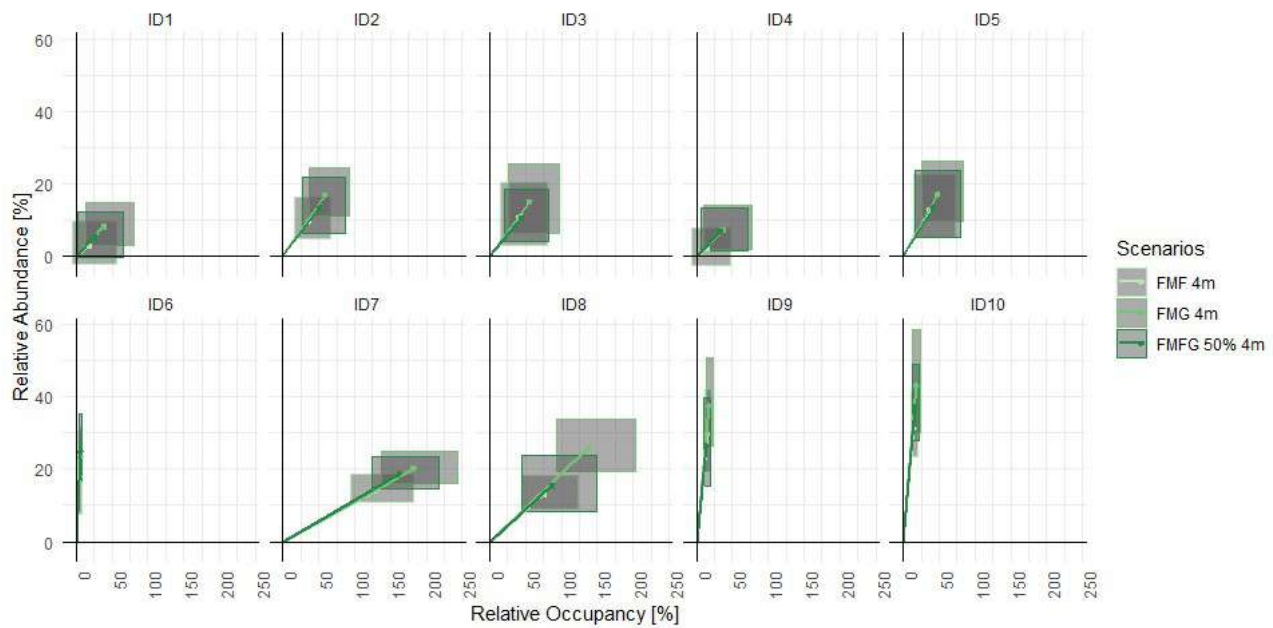


Figure 8.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes..

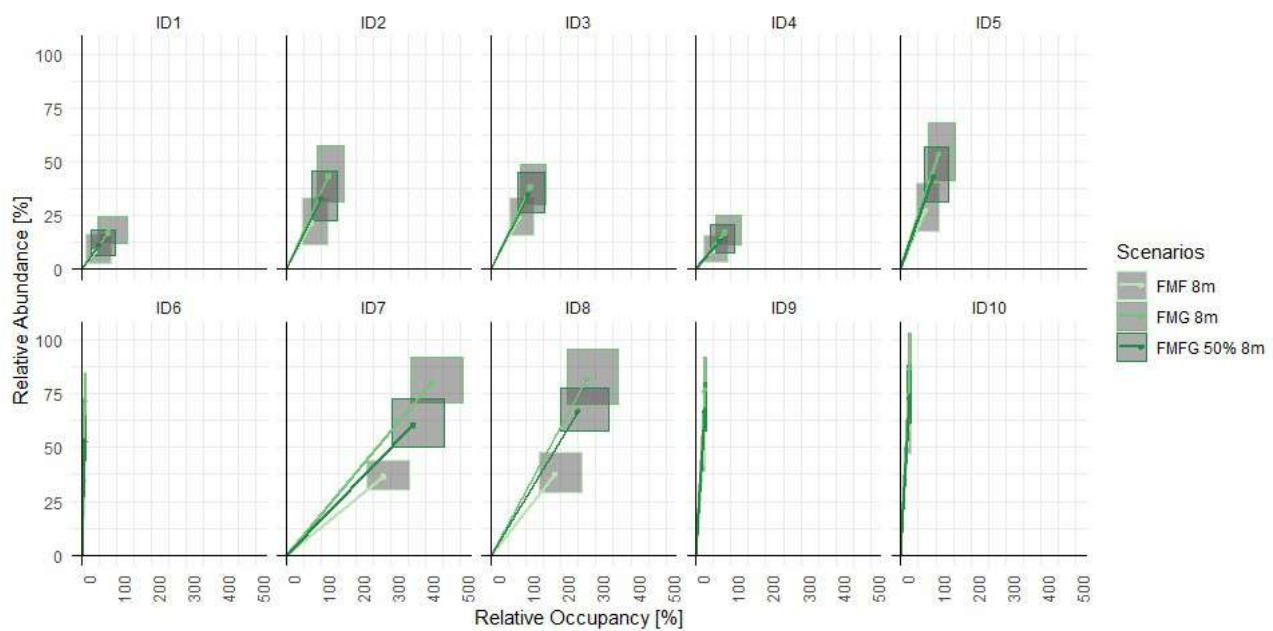


Figure 8.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.6 Setaside

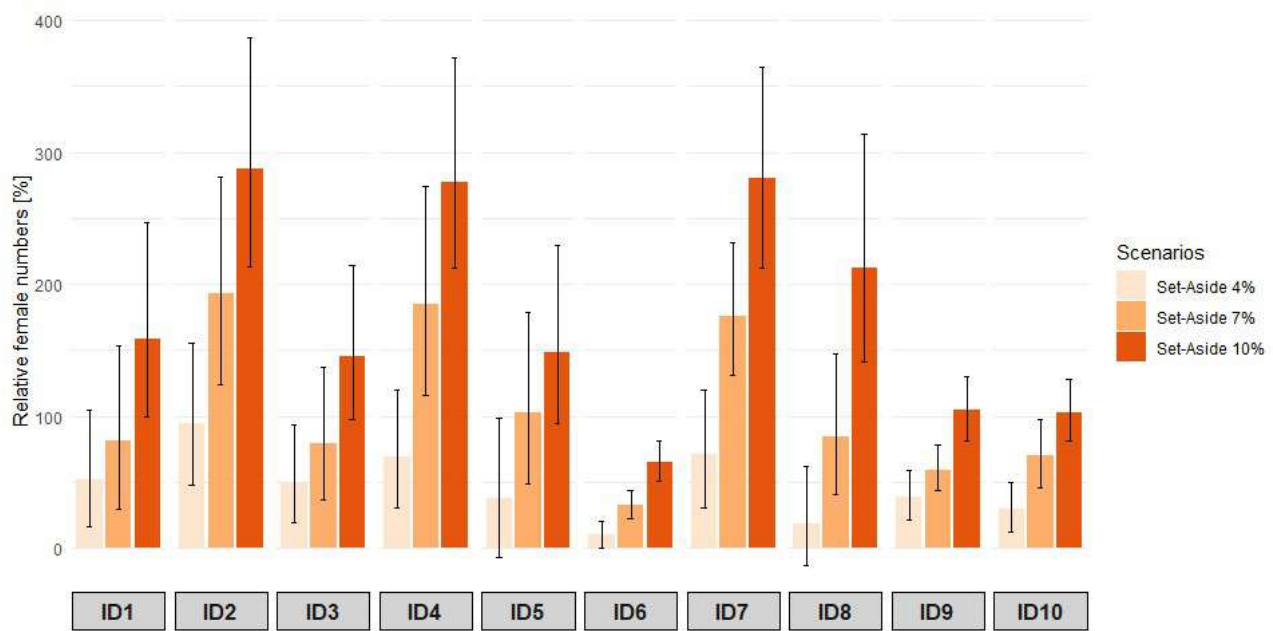


Figure 8.17 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

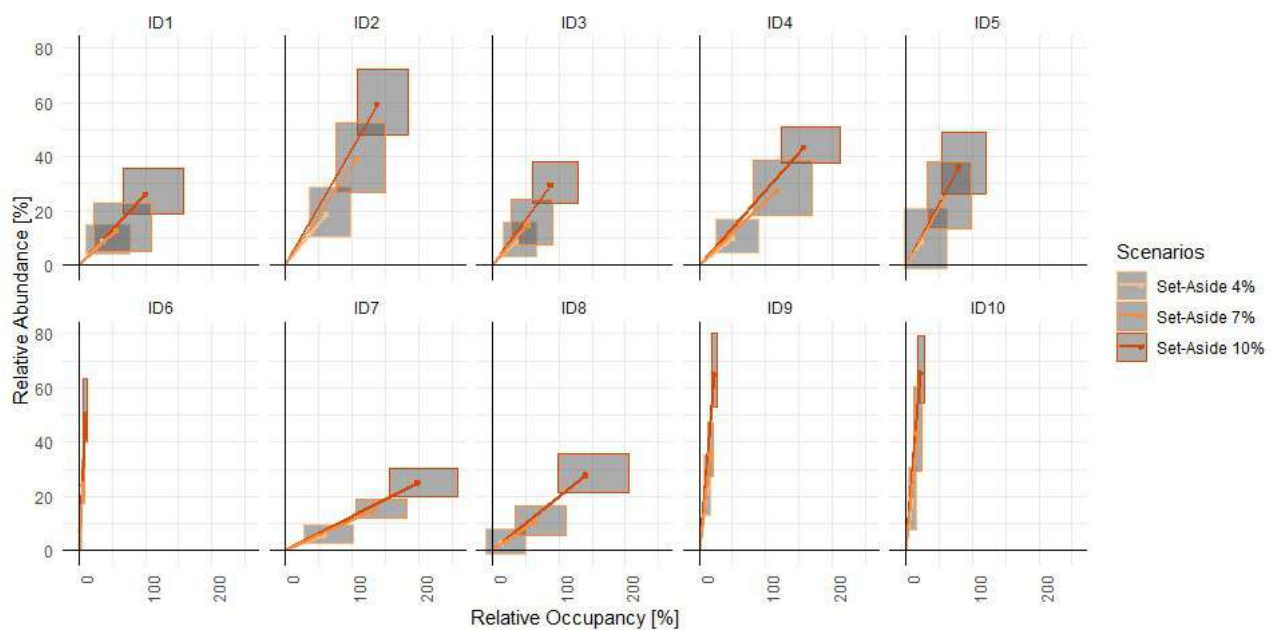


Figure 8.18 Setaside scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.7 Legume

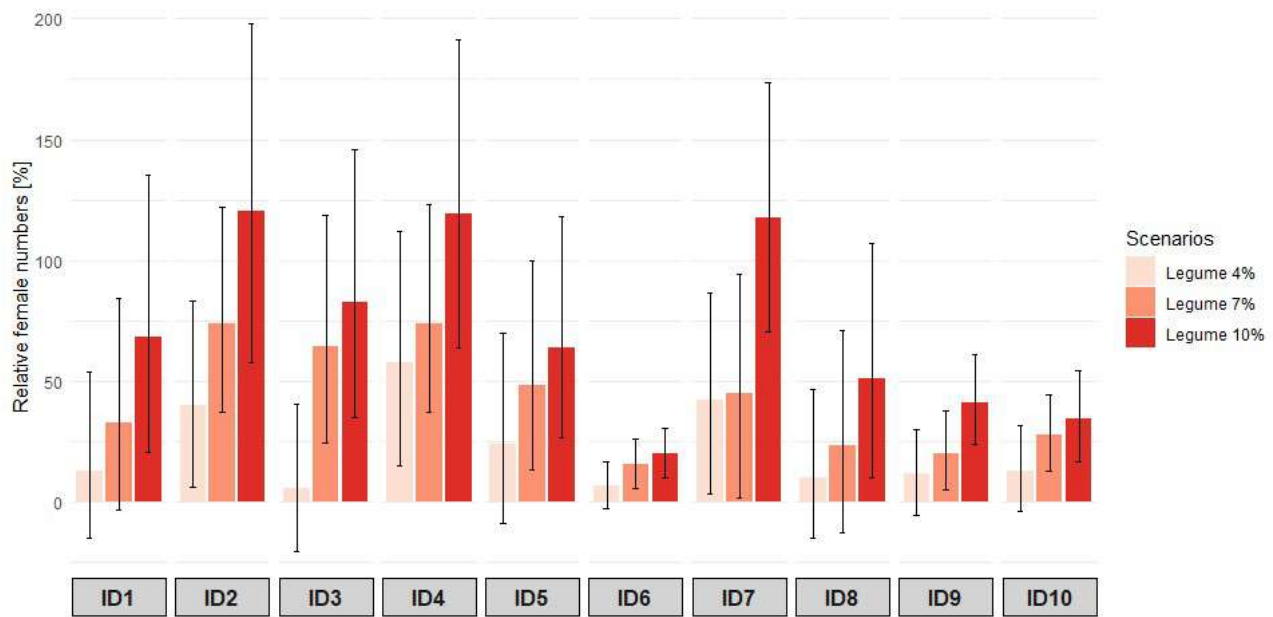


Figure 8.19 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

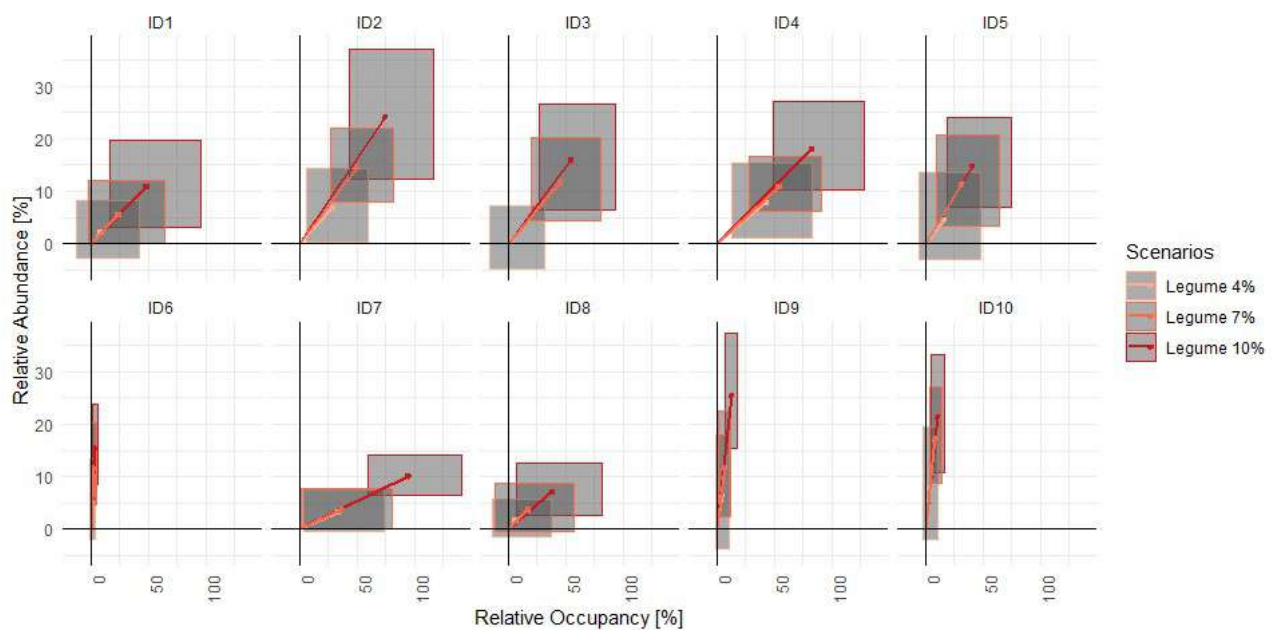


Figure 8.20 Legume scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.2.8 Biopesticides

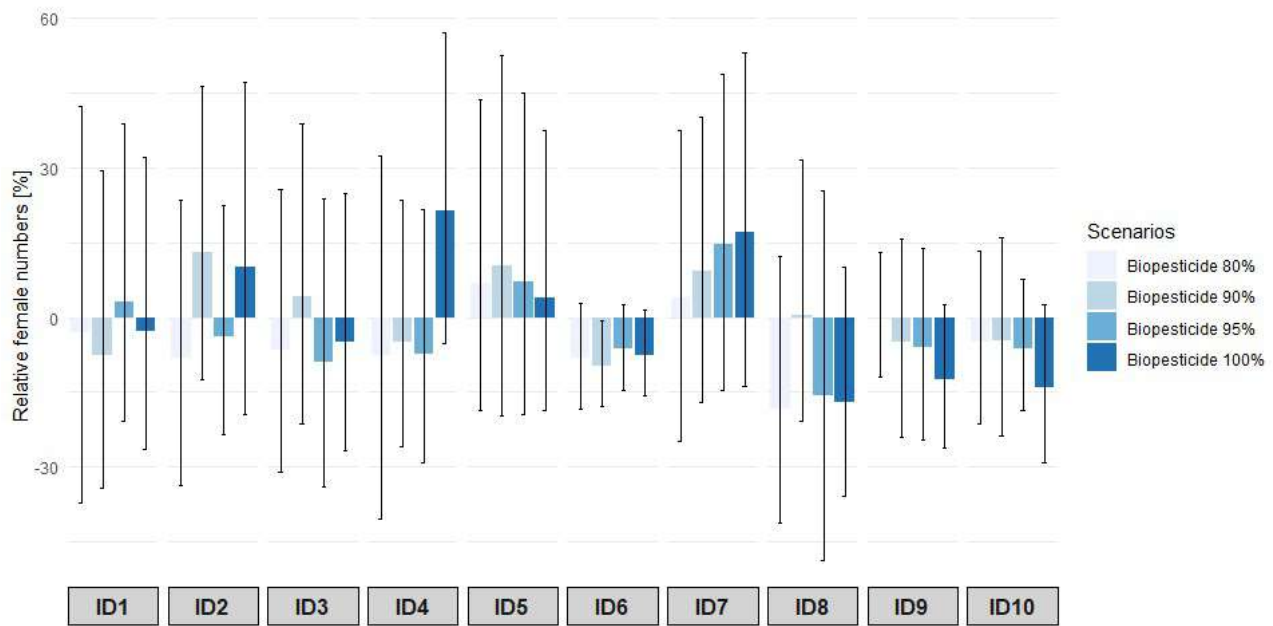


Figure 8.21 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Germany.

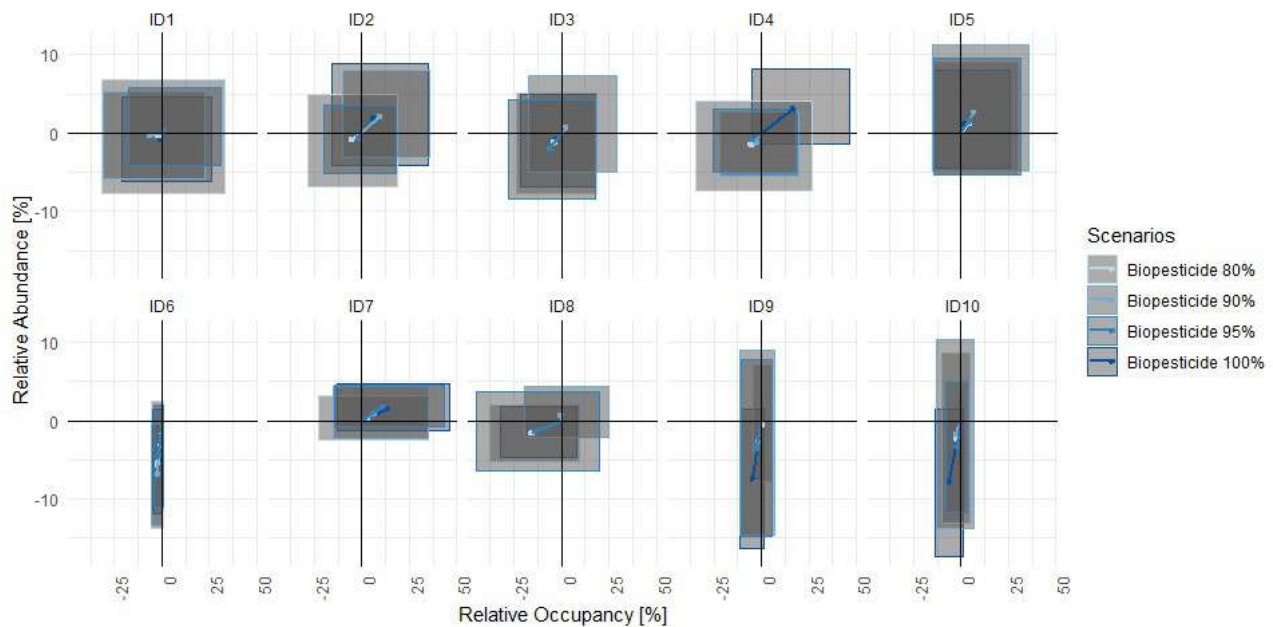


Figure 8.22 Biopesticide scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3 Denmark

8.3.1 Crop diversification

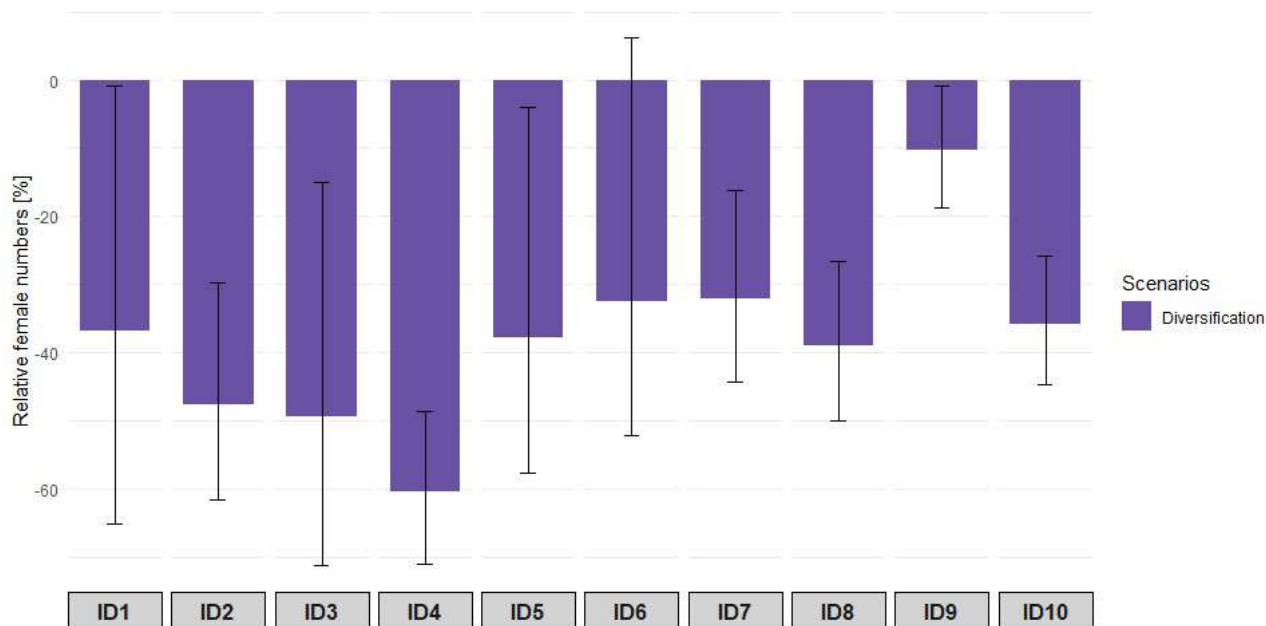


Figure 8.23 Diversification scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

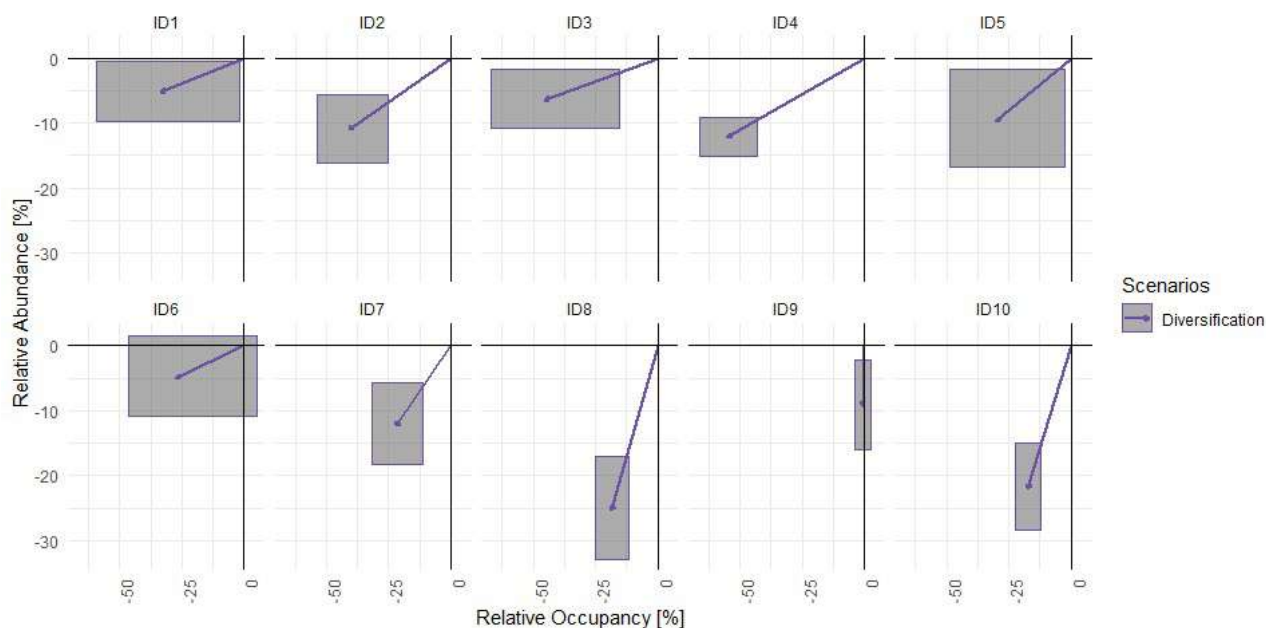


Figure 8.24 Diversification scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.2 Flower field margins

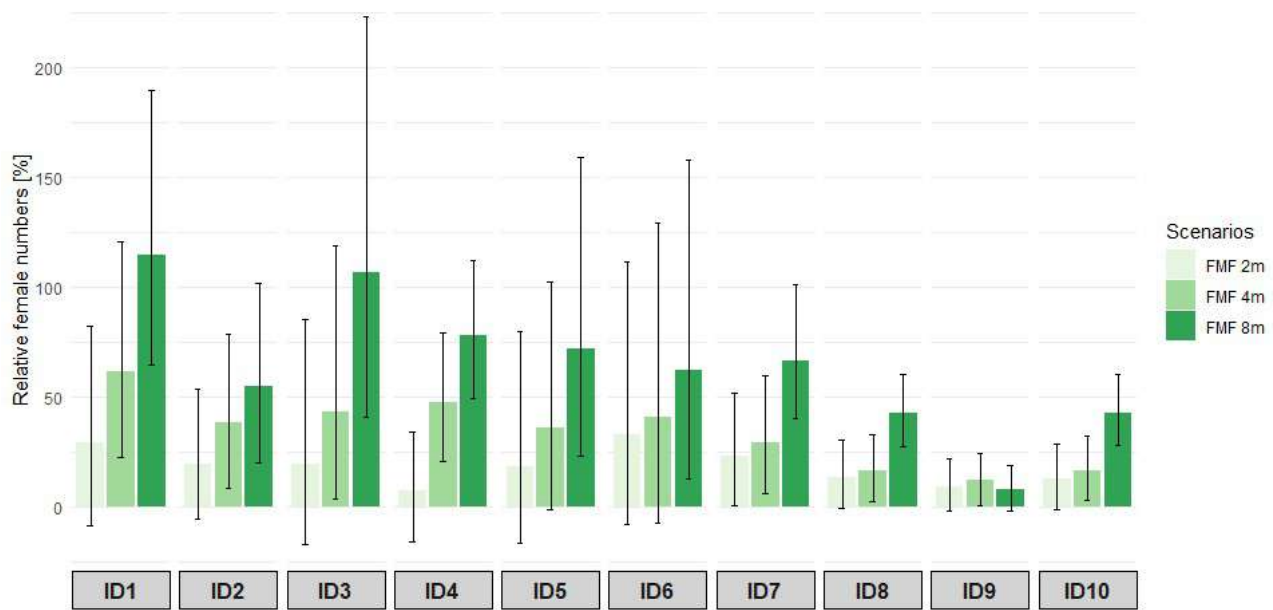


Figure 8.25 Flower field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

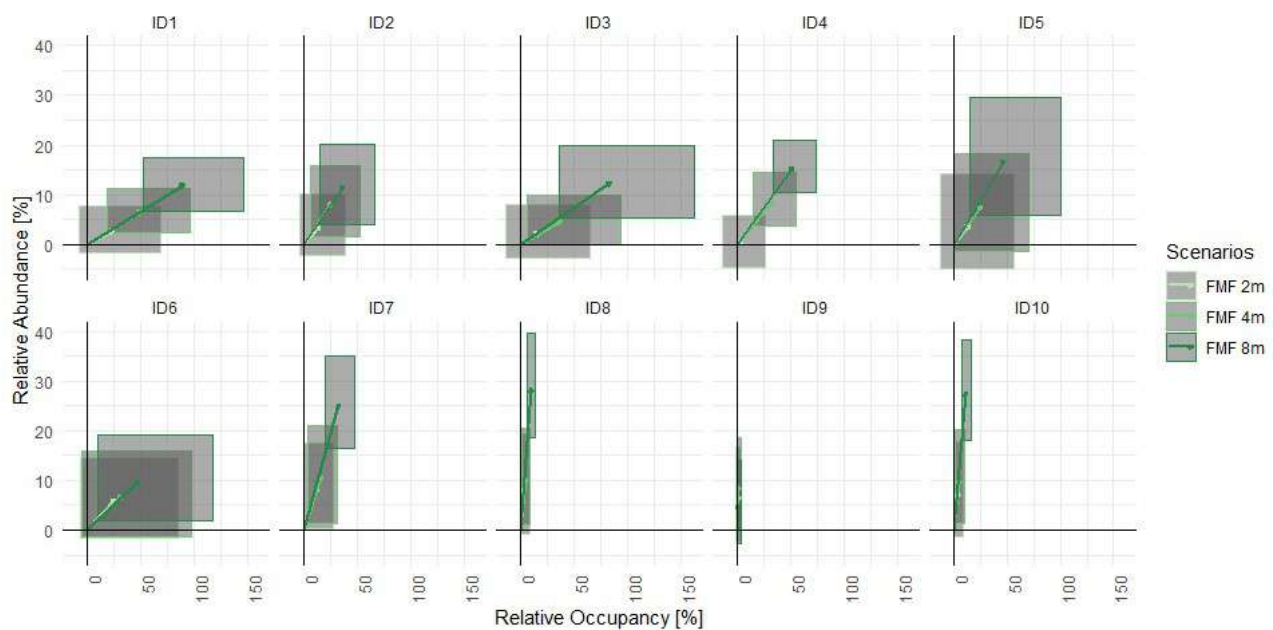


Figure 8.26 Flower field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.3 Grassy field margins

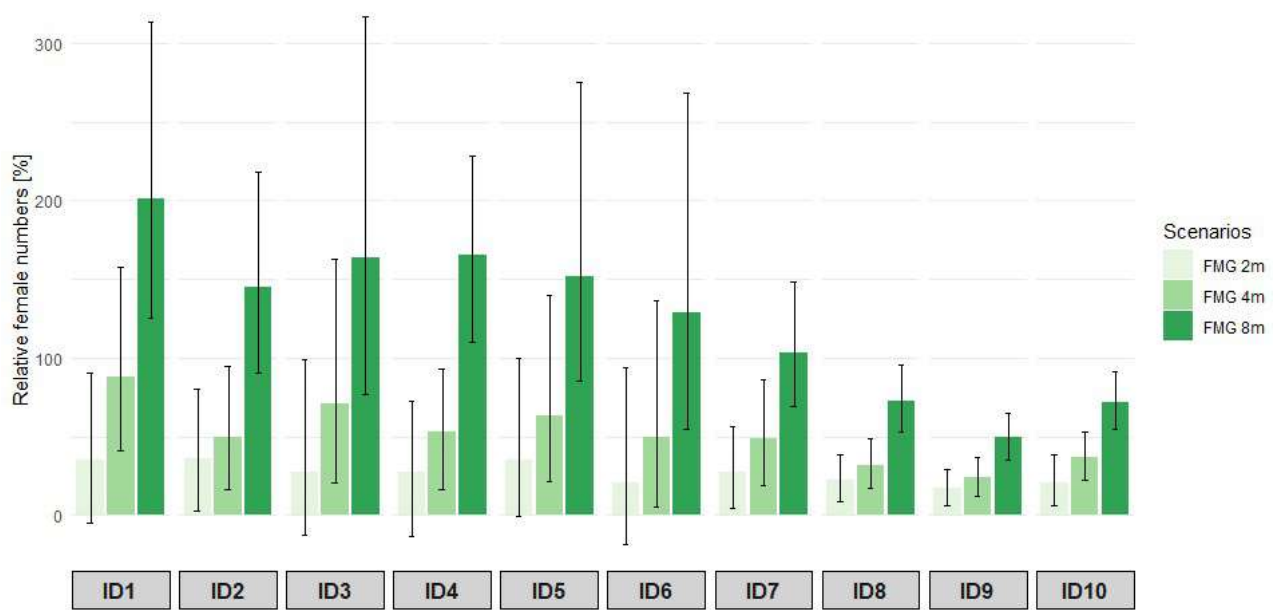


Figure 8.27 Grassy field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

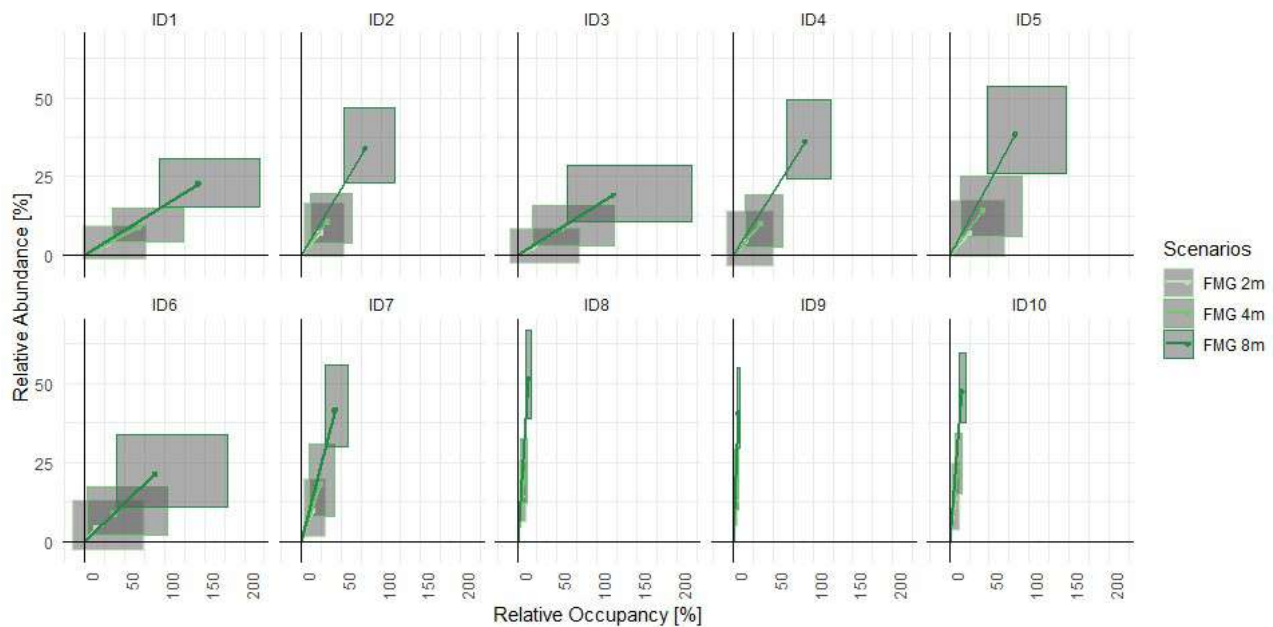


Figure 8.28 Grassy field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.4 Mixed field margins

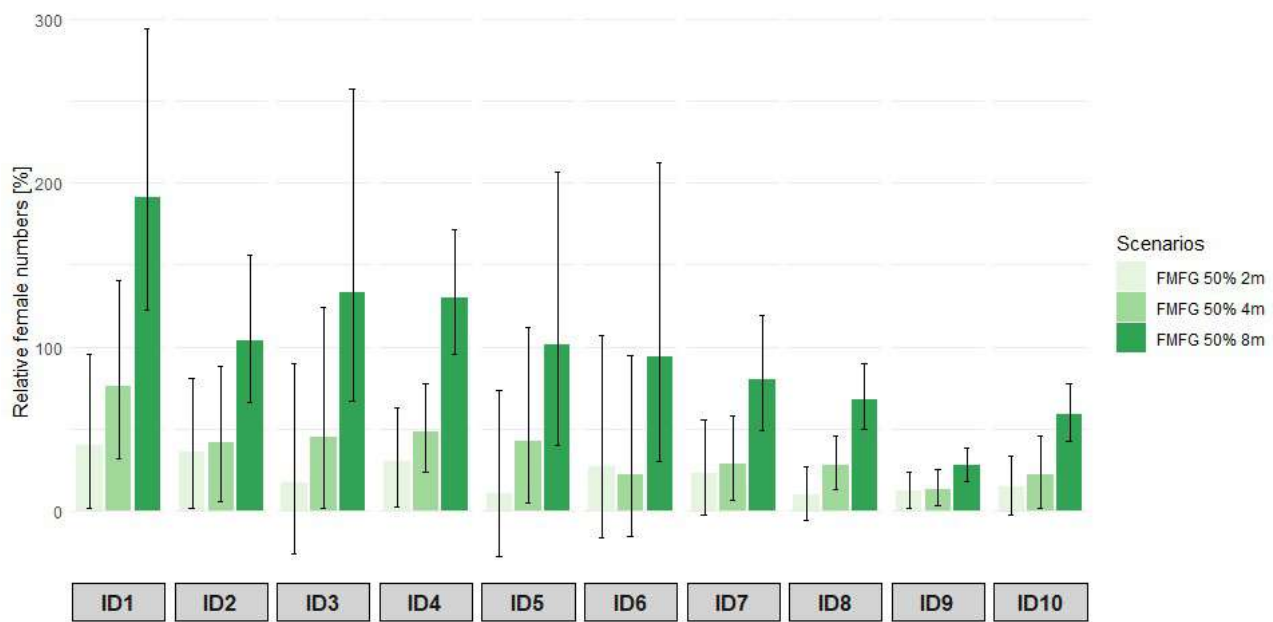


Figure 8.29 Mixed field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

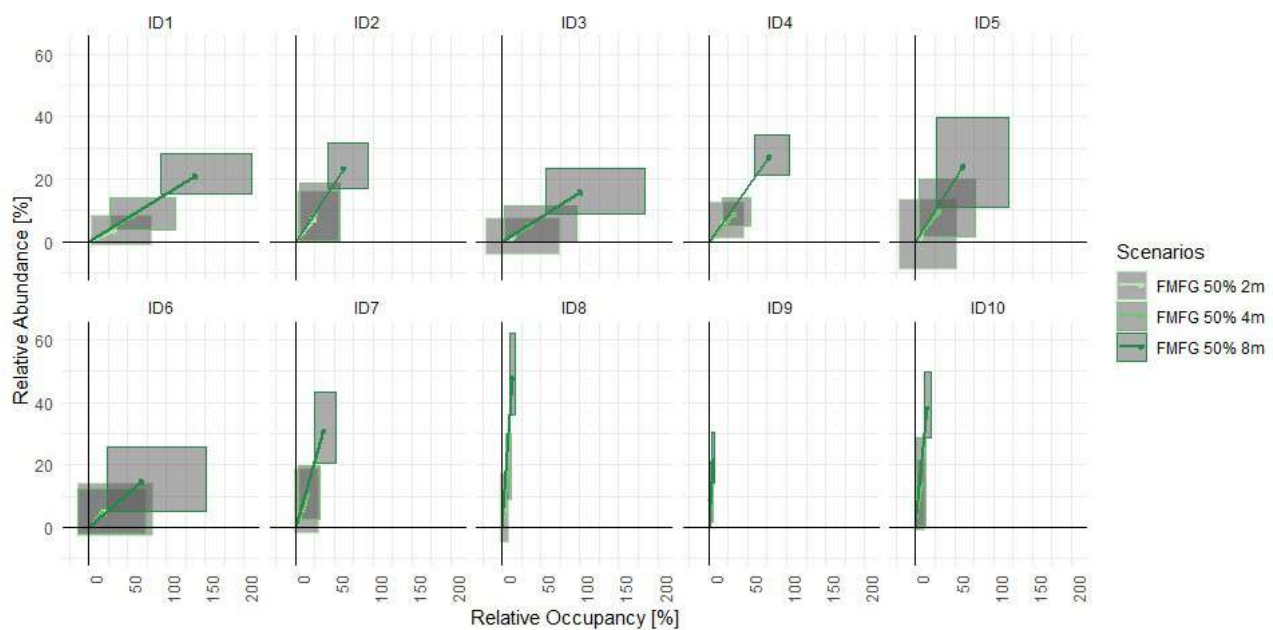


Figure 8.30 Mixed field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.5 Flower, grassy and mixed field margins

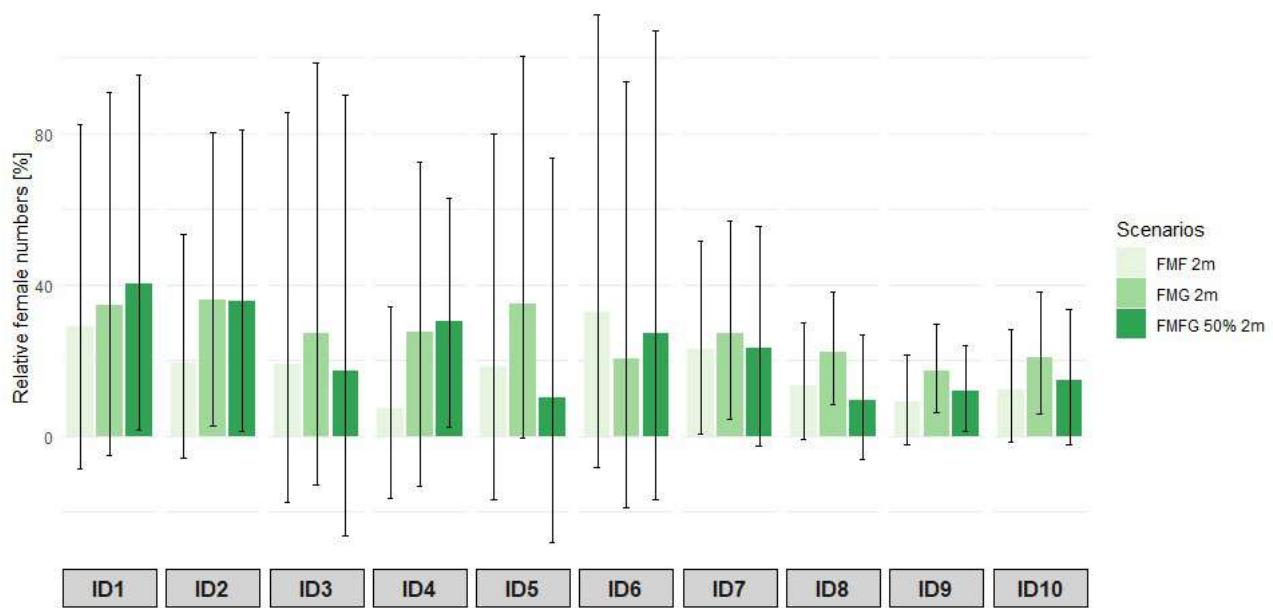


Figure 8.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

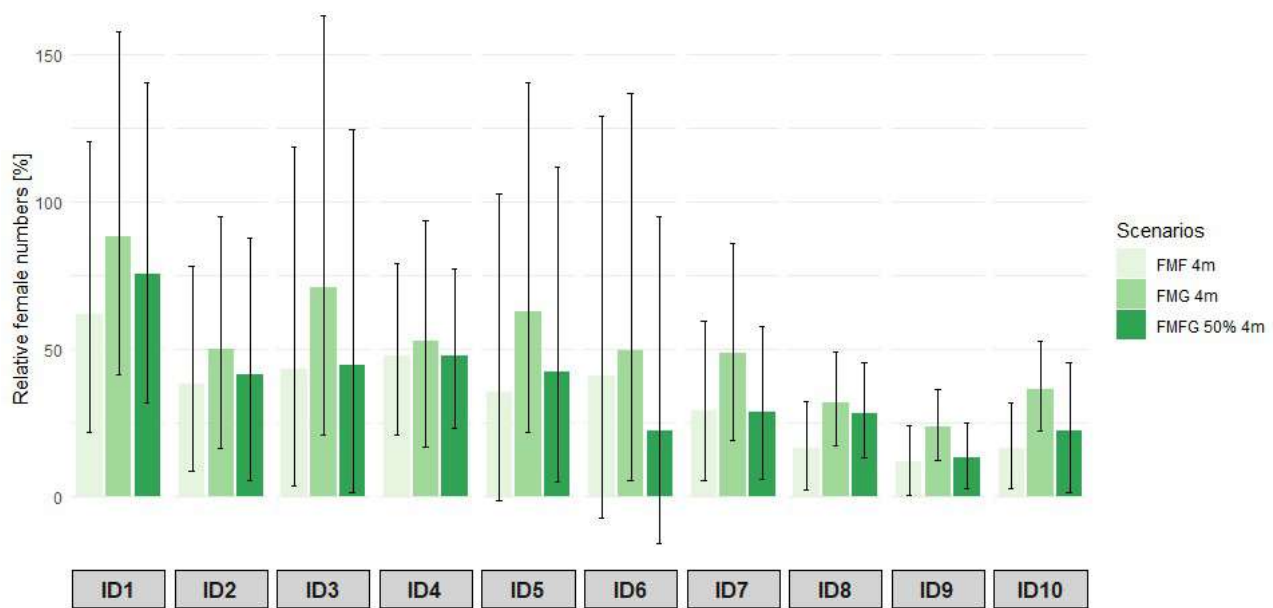


Figure 8.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

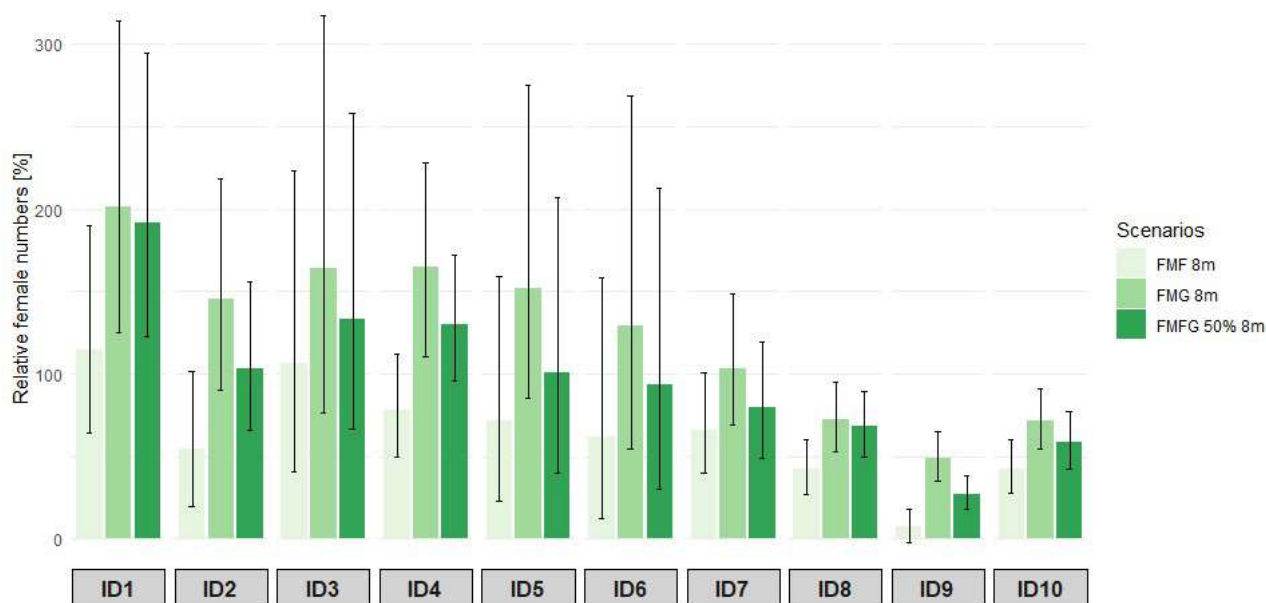


Figure 8.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

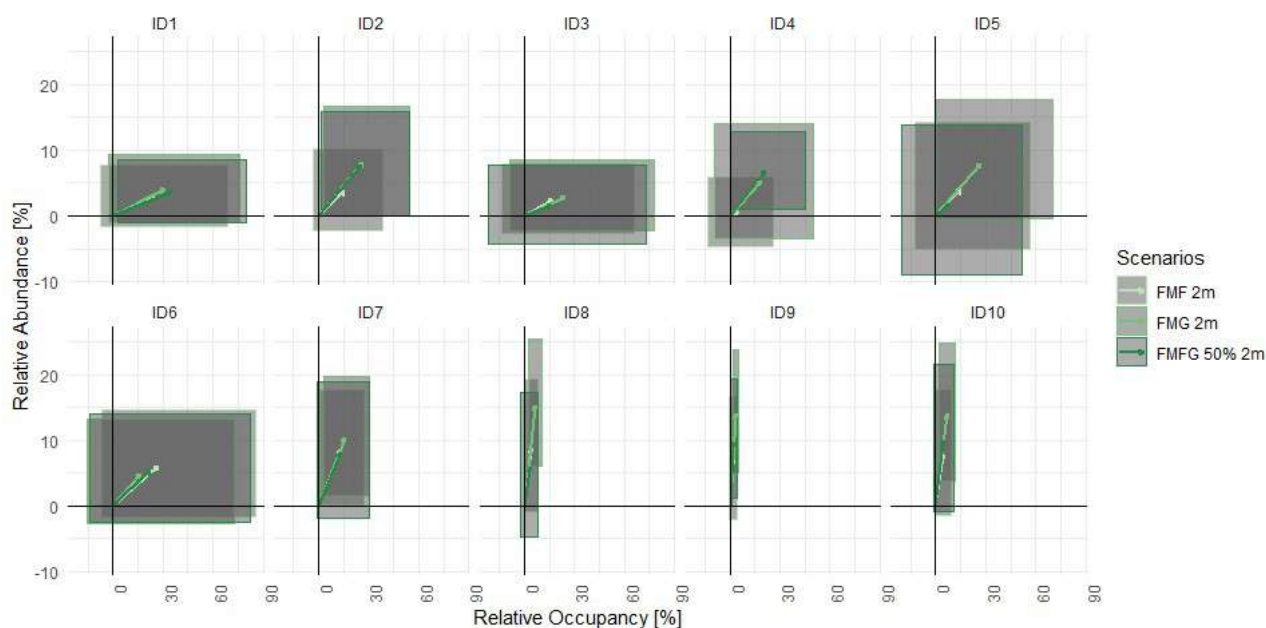


Figure 8.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

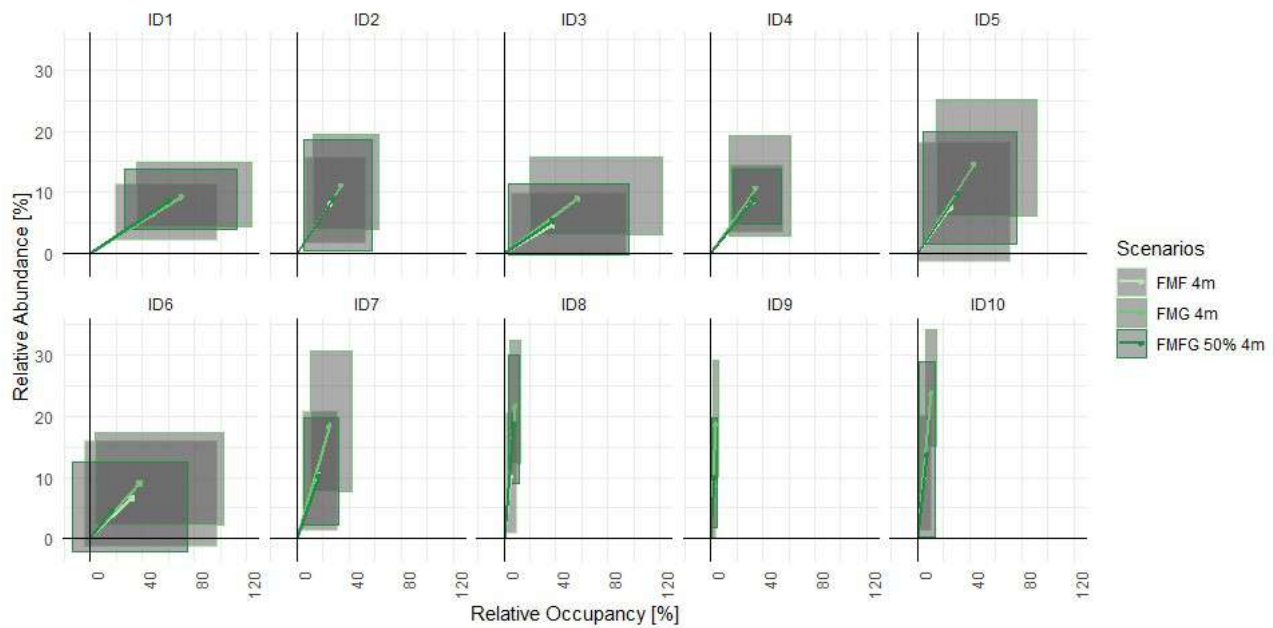


Figure 8.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes..

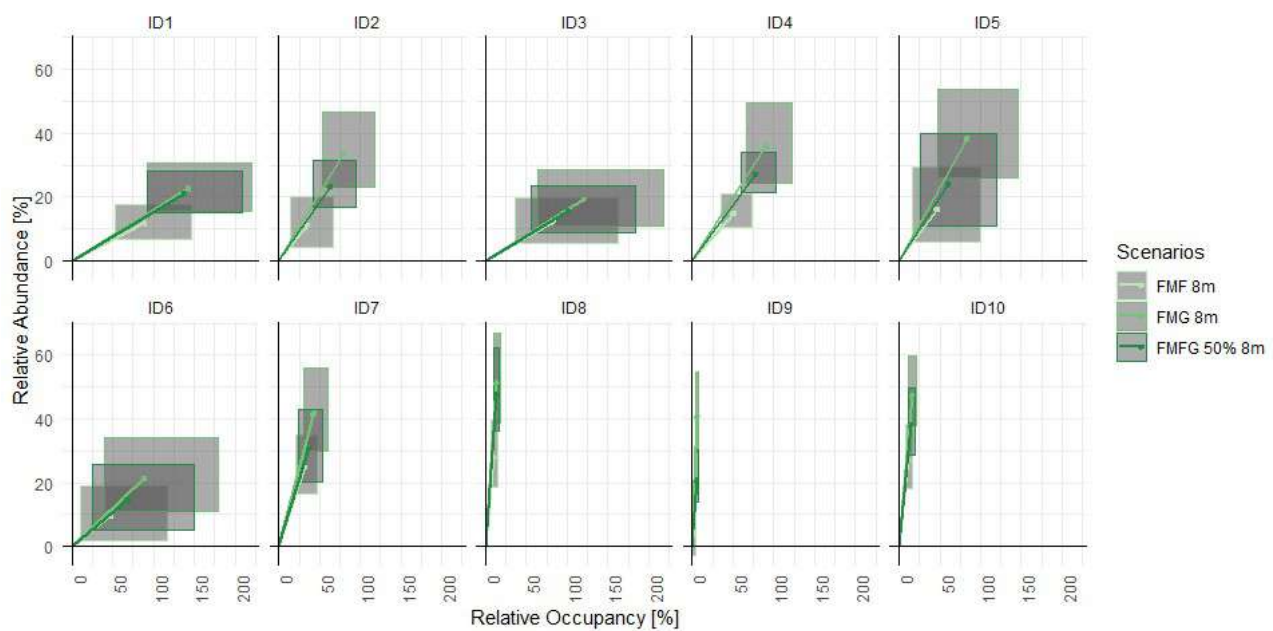


Figure 8.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.6 Setaside

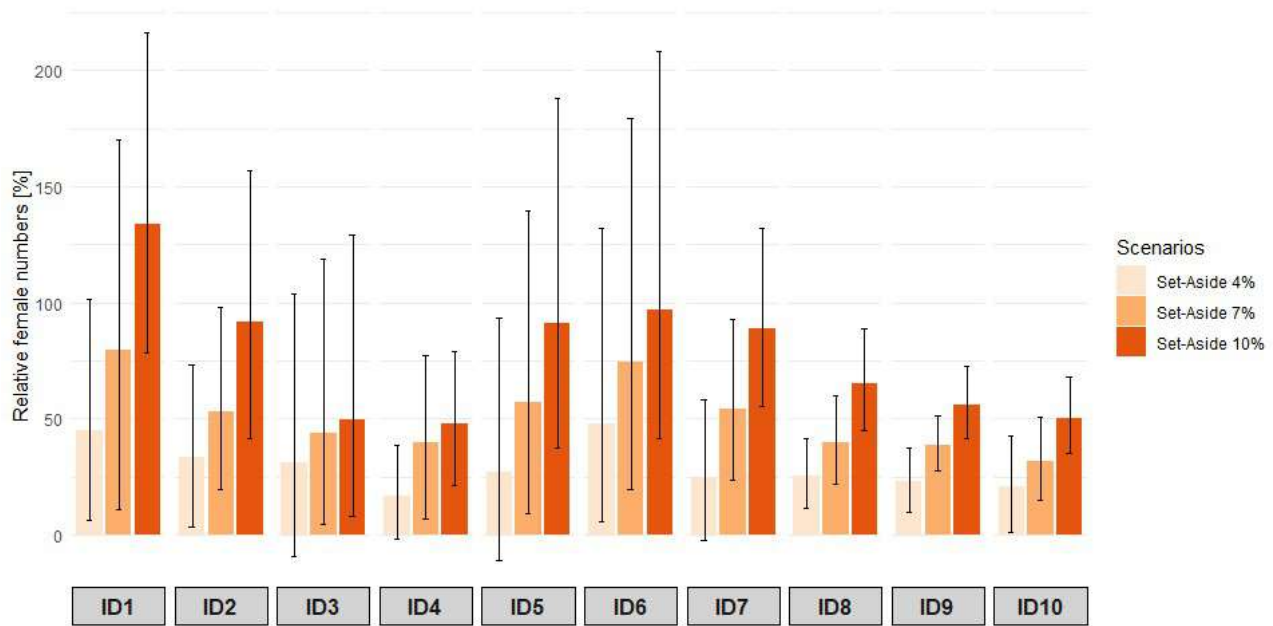


Figure 8.37 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

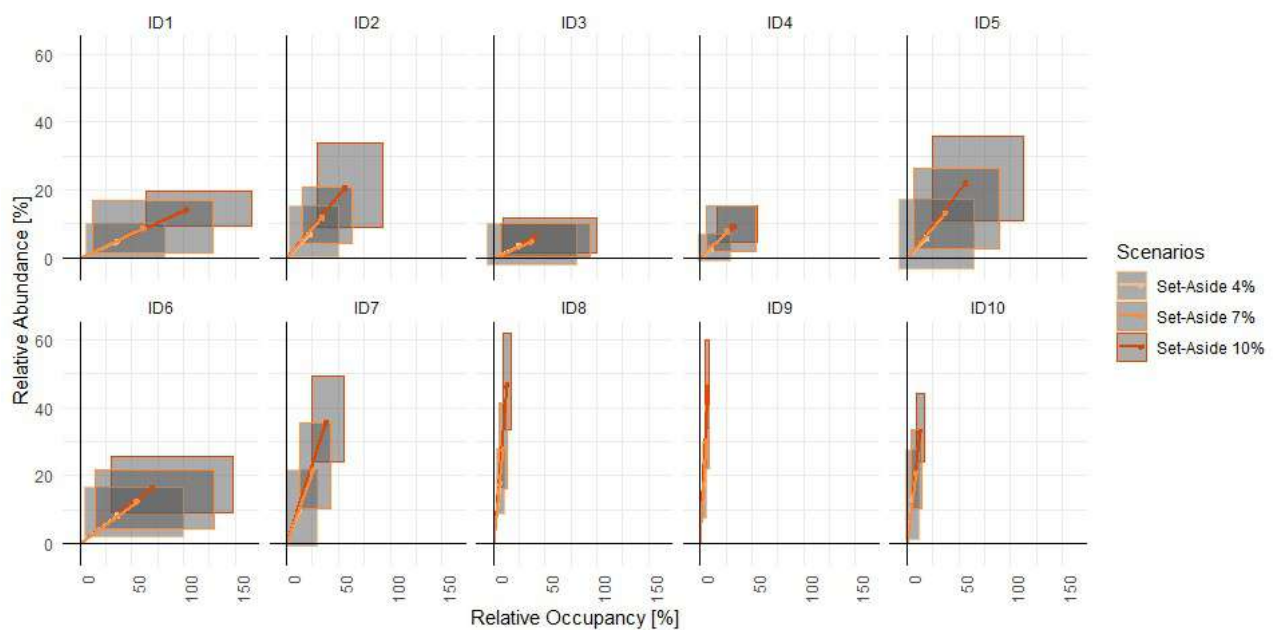


Figure 8.38 Setaside scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.7 Legume

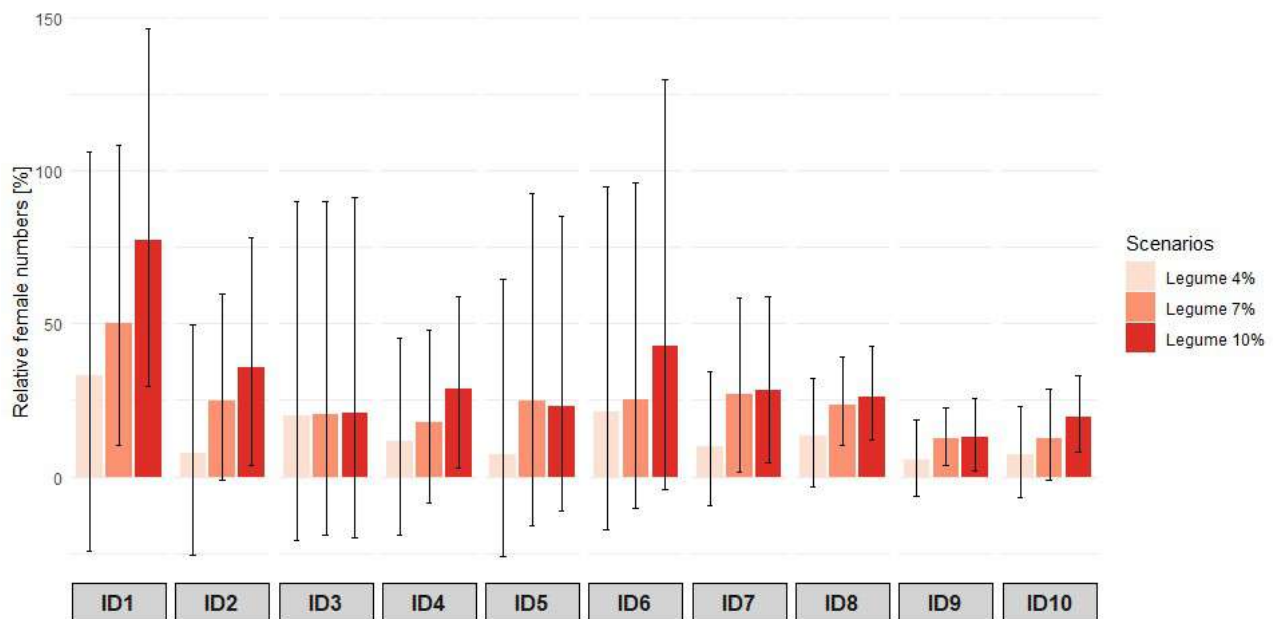


Figure 8.39 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

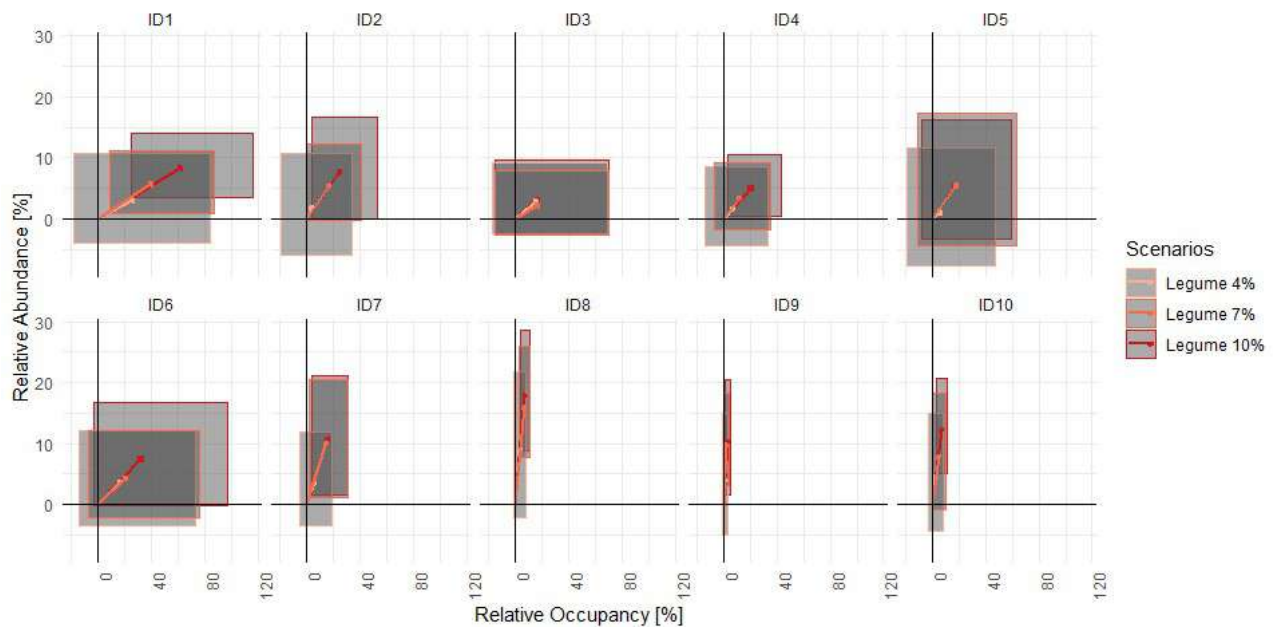


Figure 8.40 Legume scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.3.8 Biopesticides

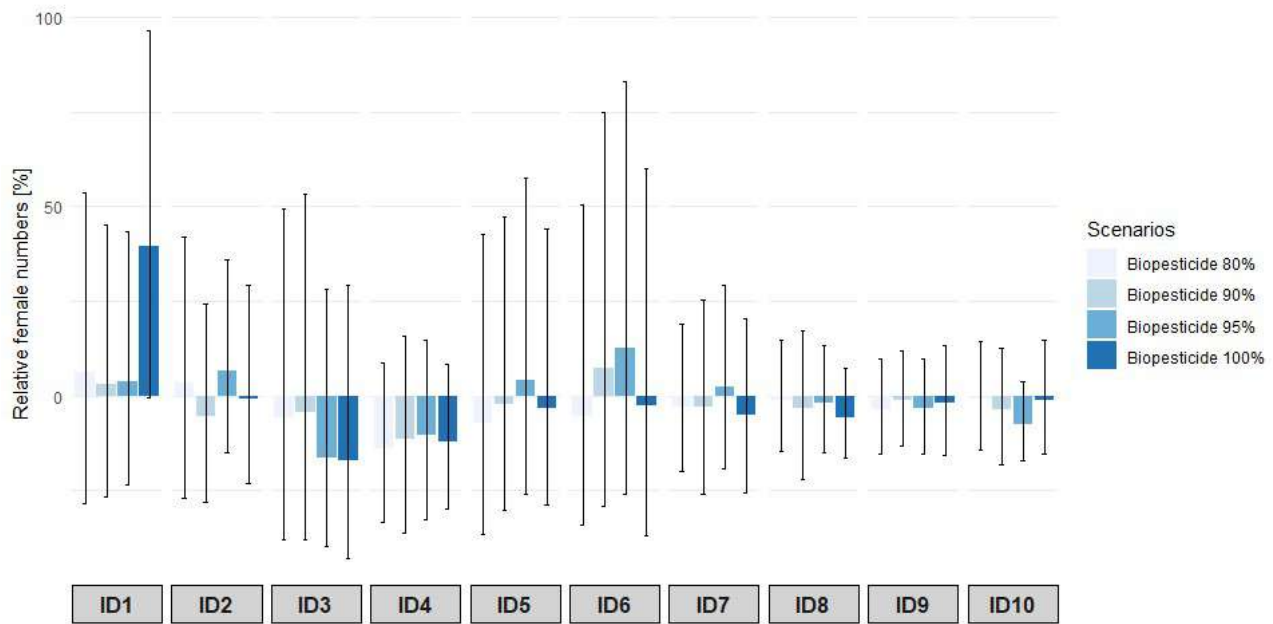


Figure 8.41 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

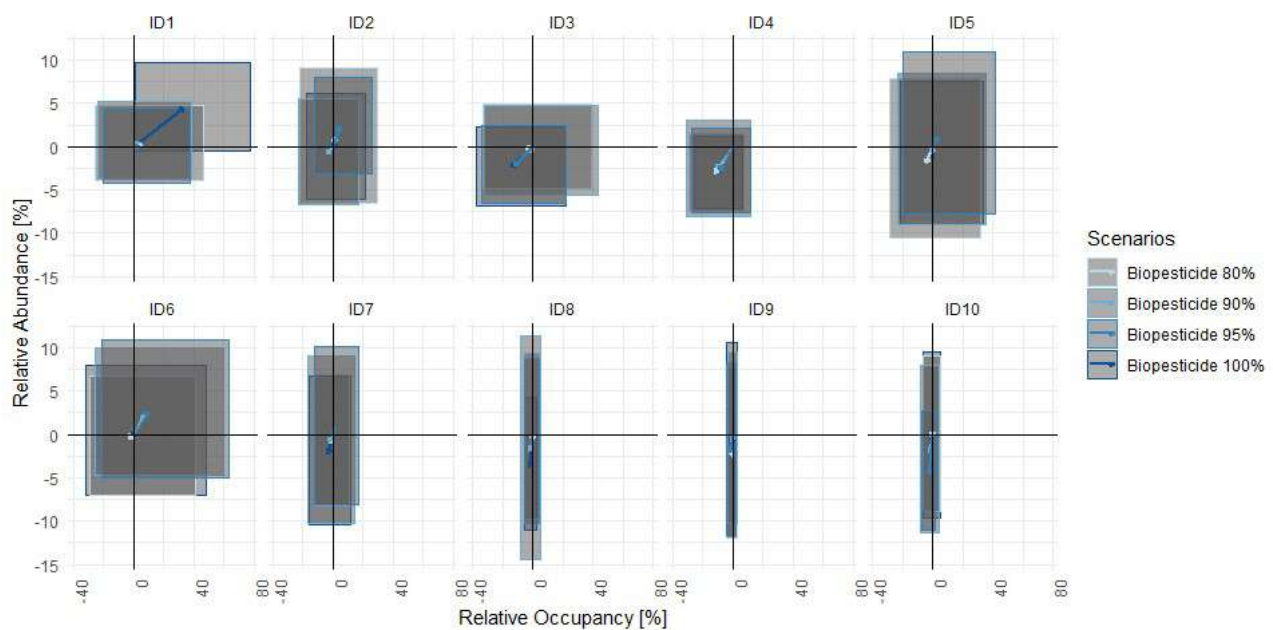


Figure 8.42 Biopesticide scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4 Poland

8.4.1 Flower field margins

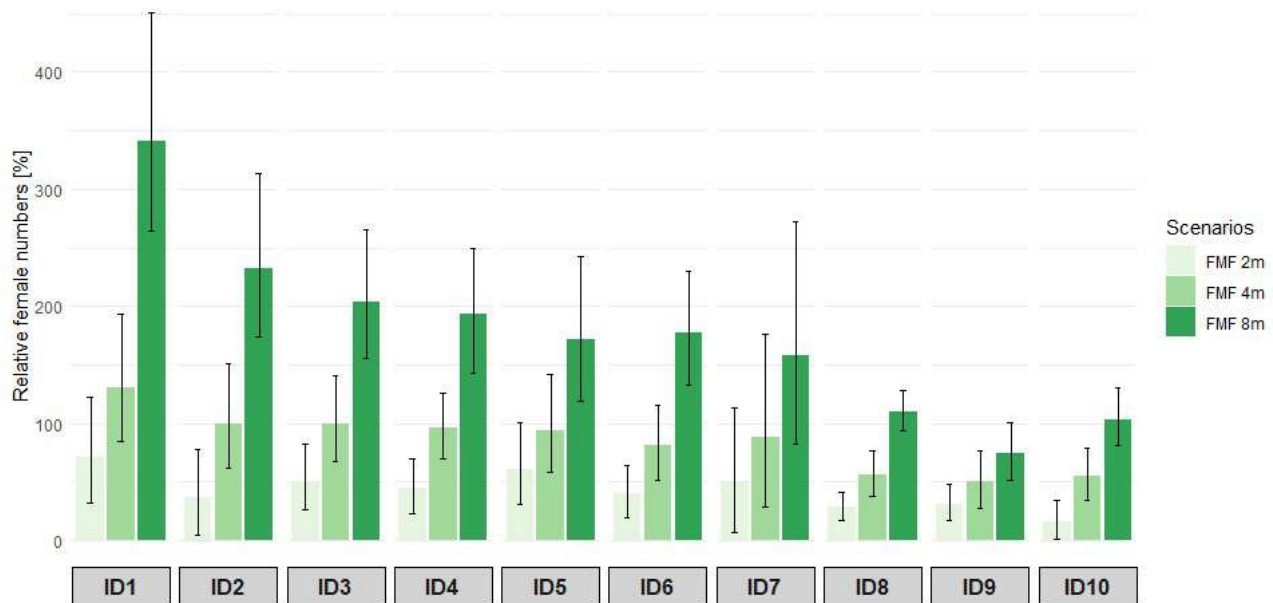


Figure 8.43 Flower field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

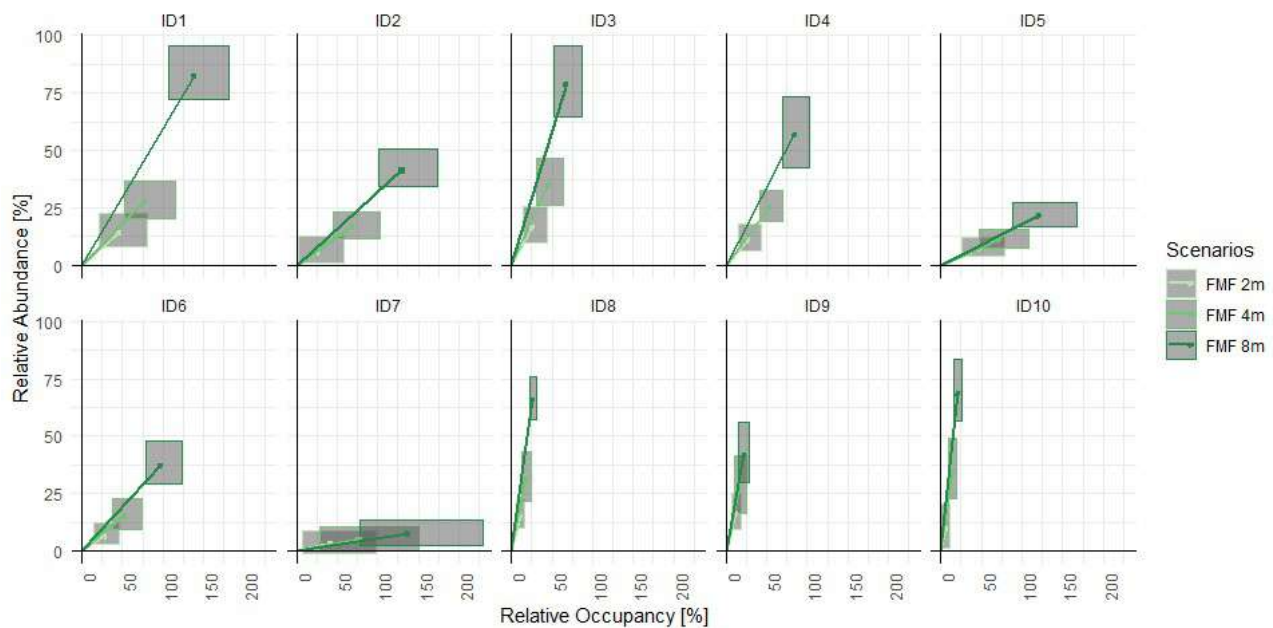


Figure 8.44 Flower field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4.2 Grassy field margins

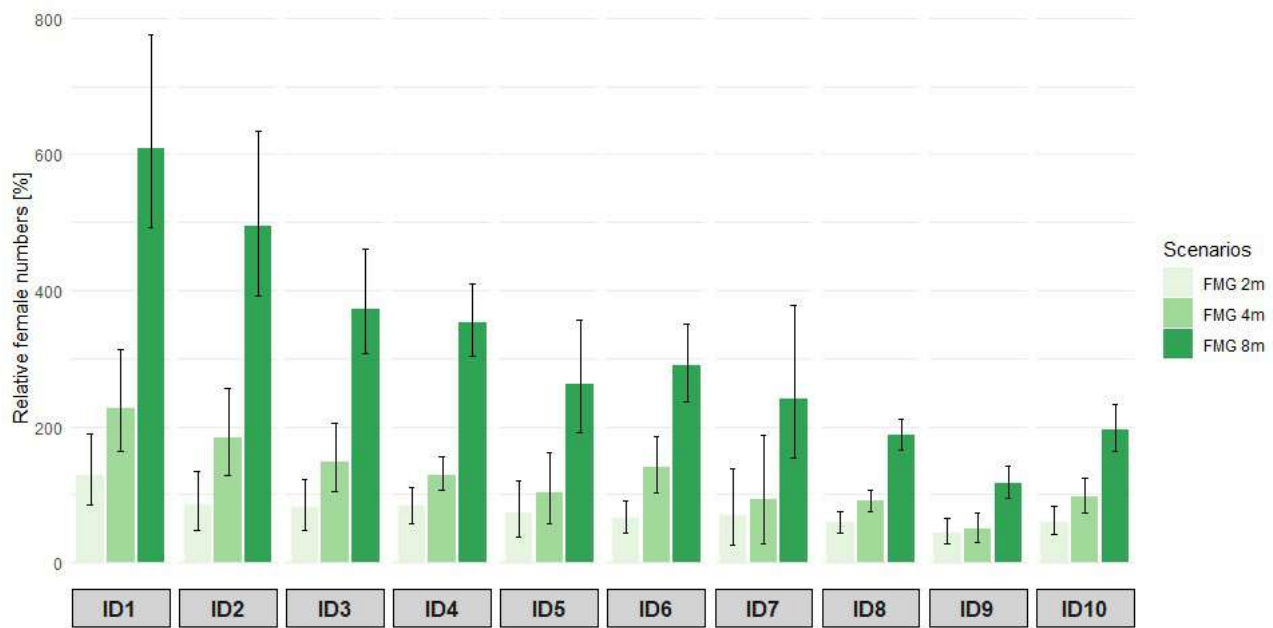


Figure 8.45 Grassy field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

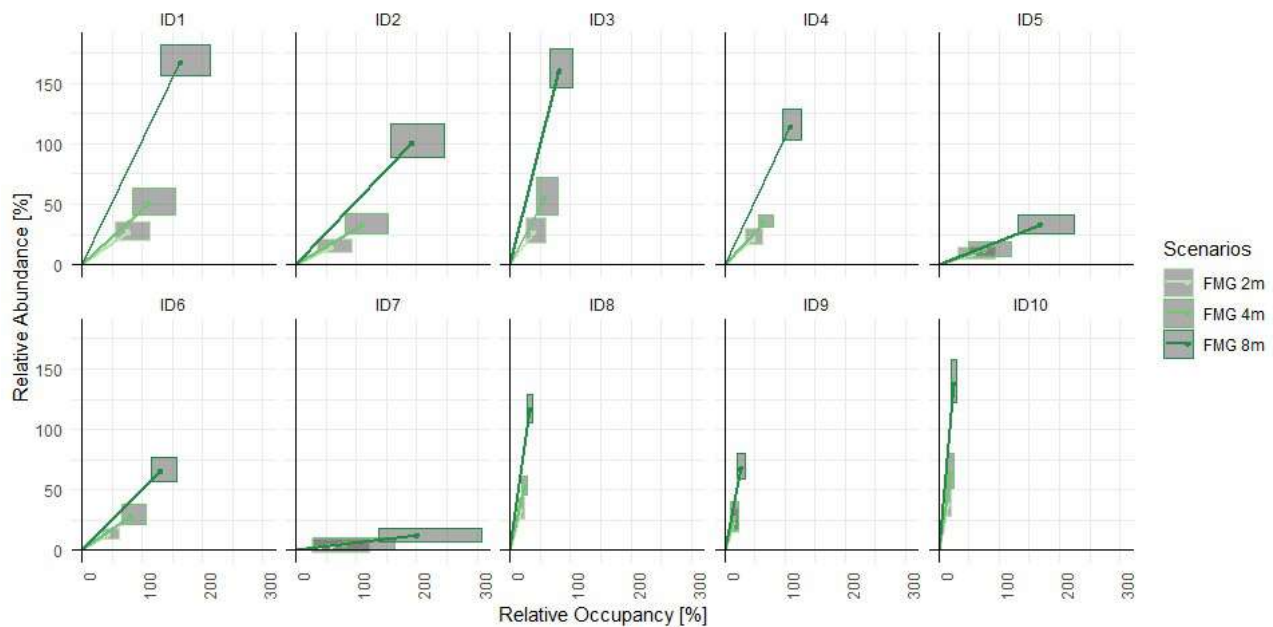


Figure 8.46 Grassy field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4.3 Mixed field margins

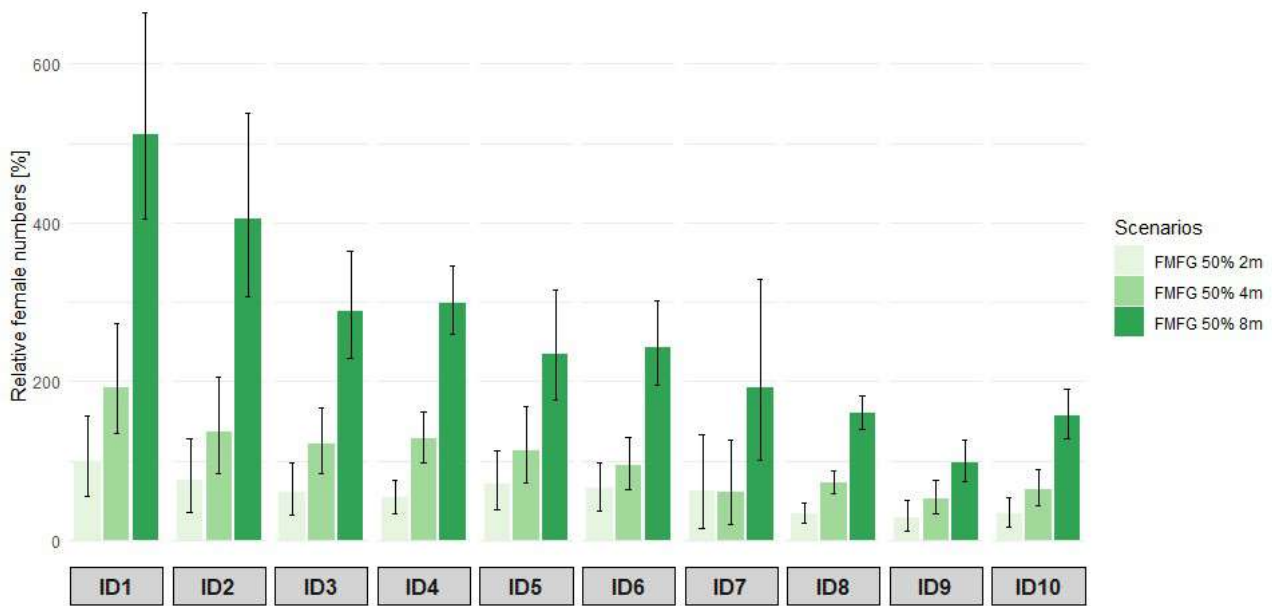


Figure 8.47 Mixed field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

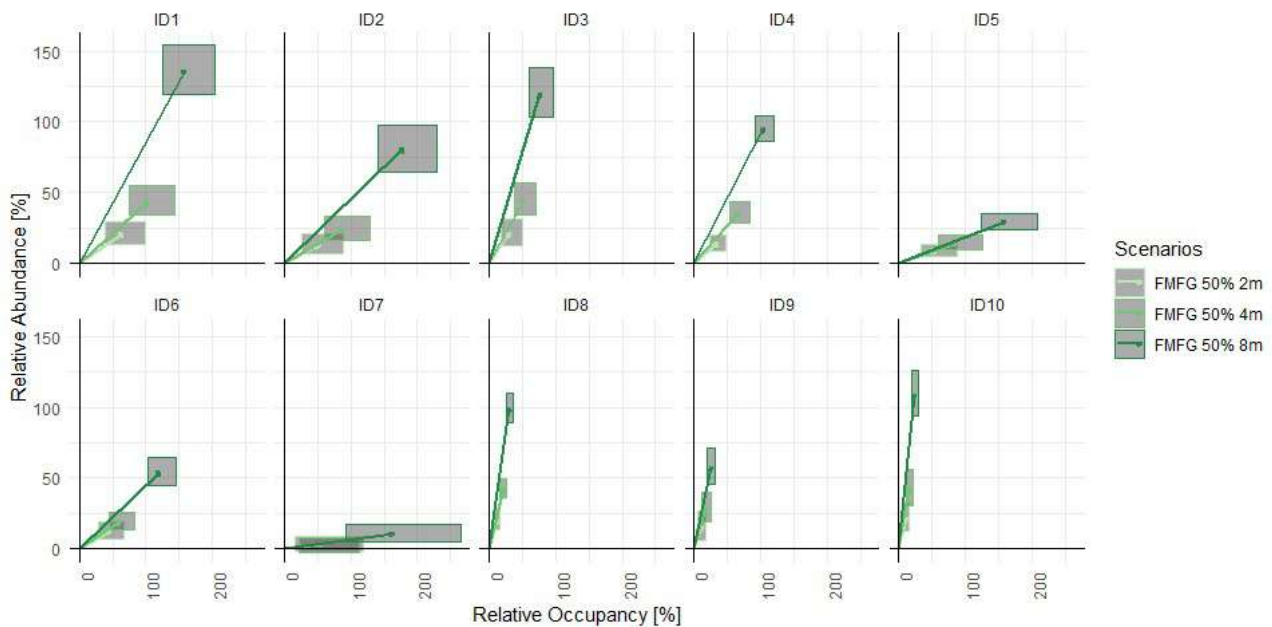


Figure 8.48 Mixed field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4.4 Flower, grassy and mixed field margins

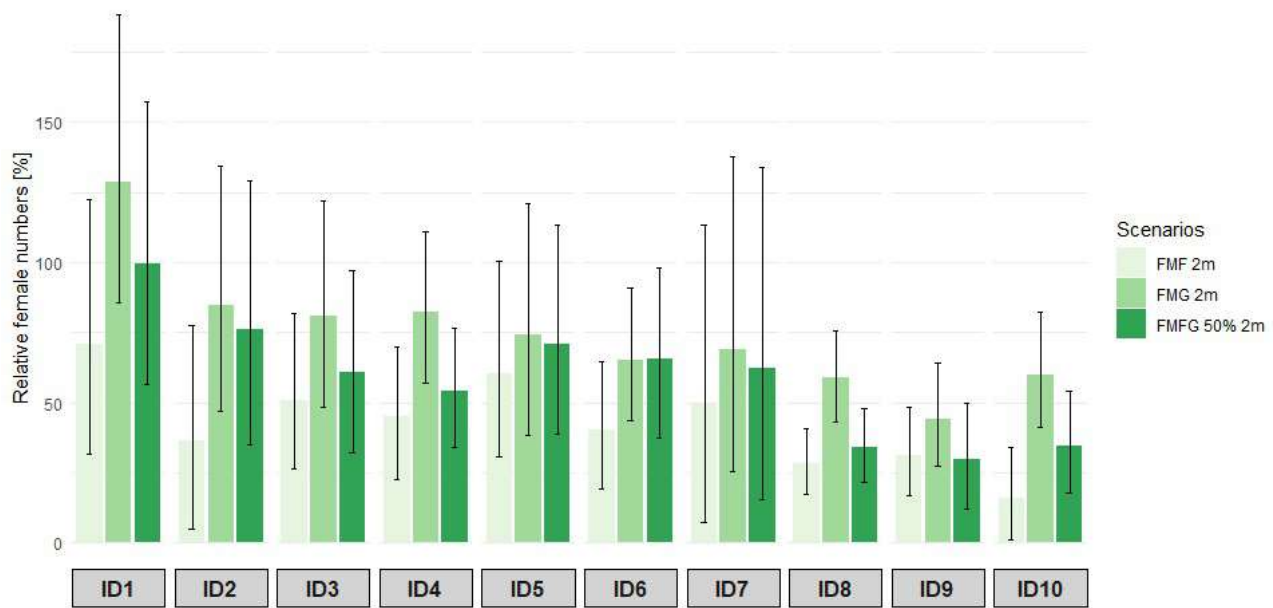


Figure 8.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

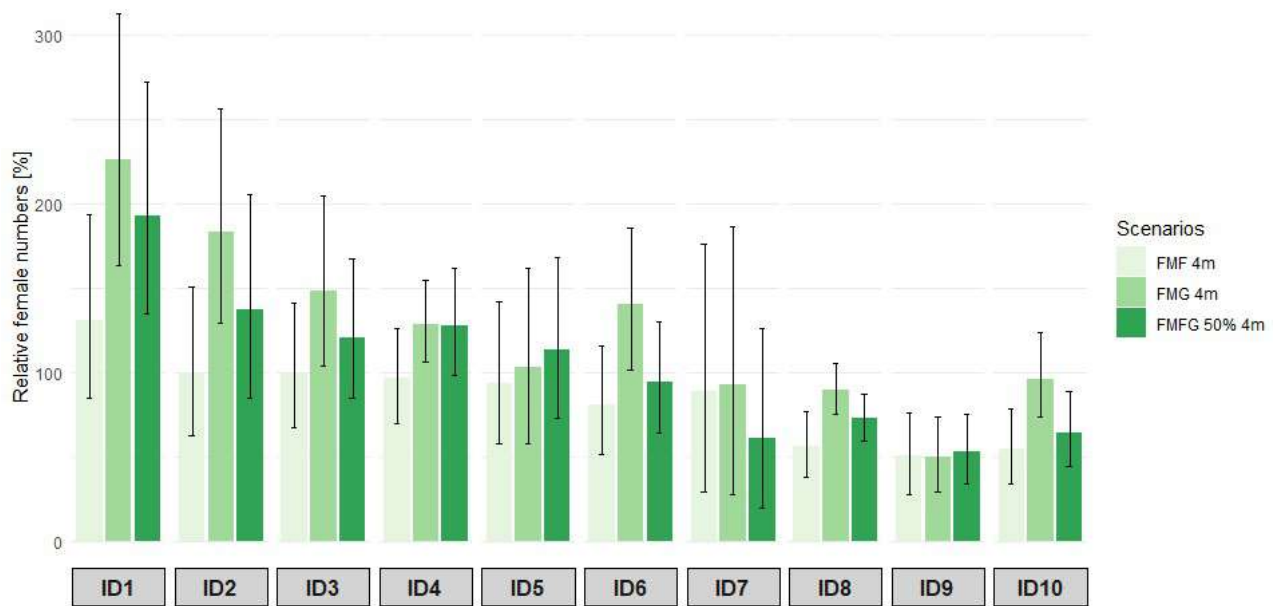


Figure 8.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

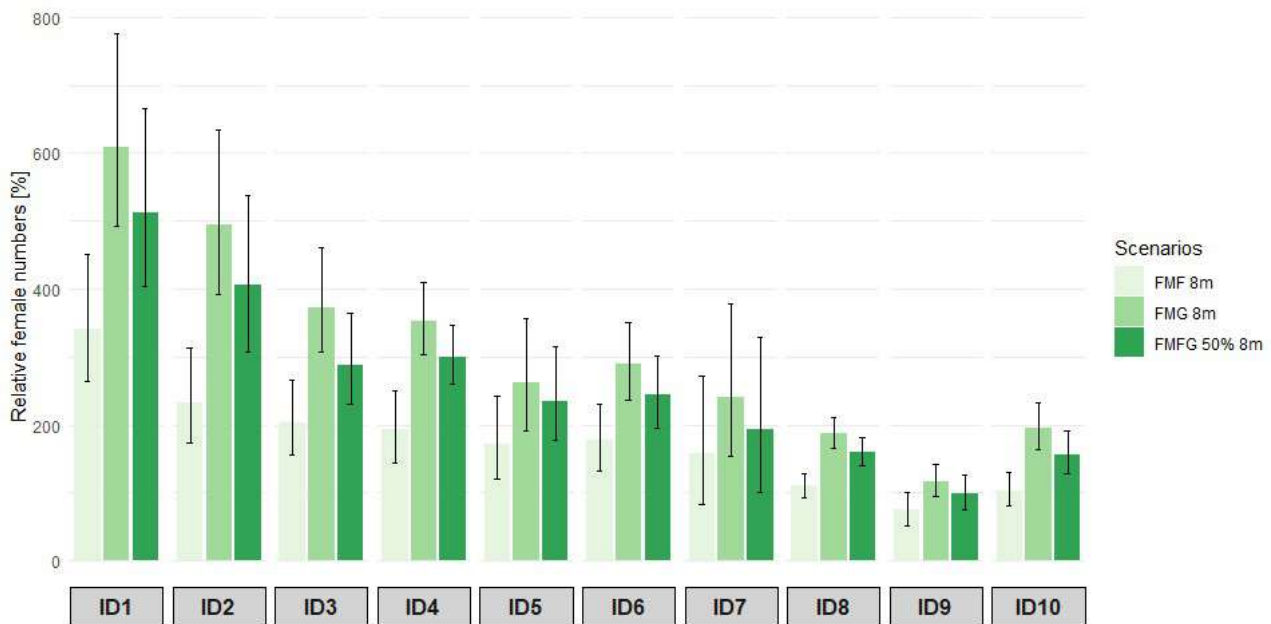


Figure 8.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

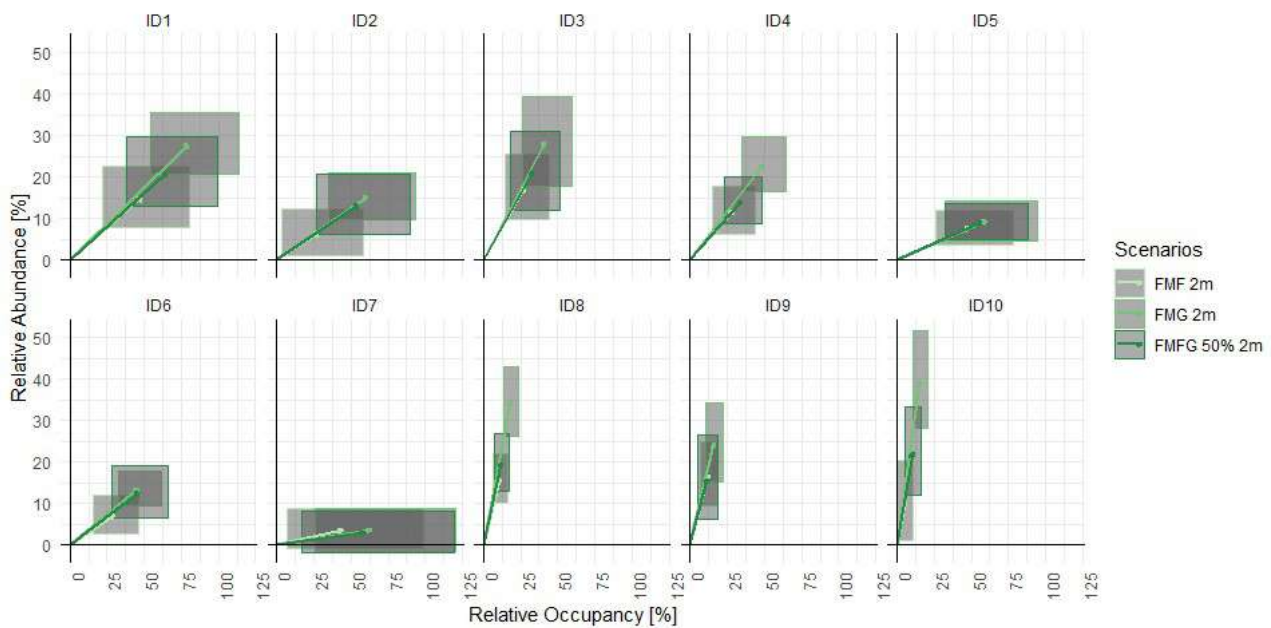


Figure 8.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

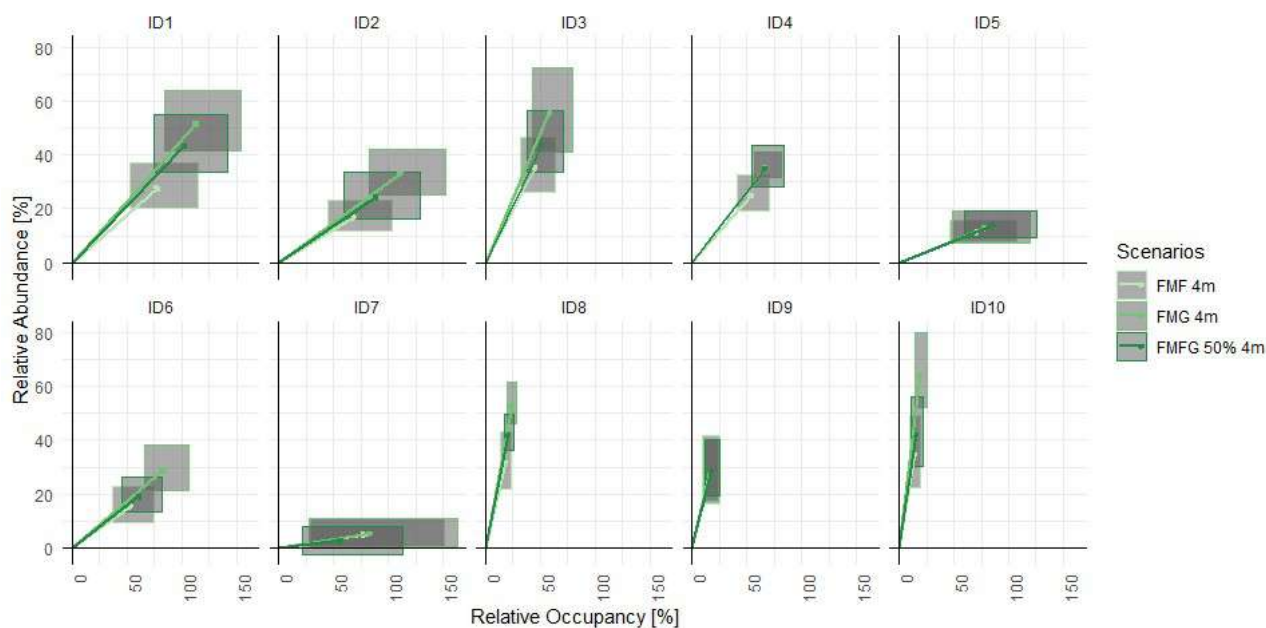


Figure 8.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes..

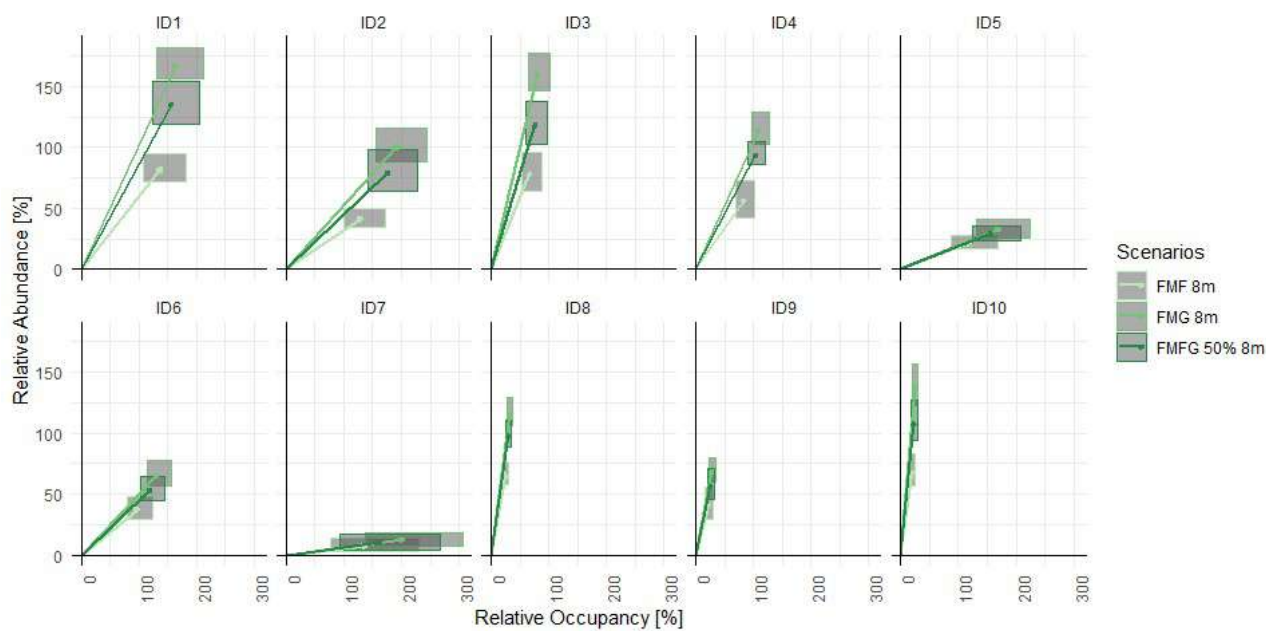


Figure 8.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4.5 Setaside

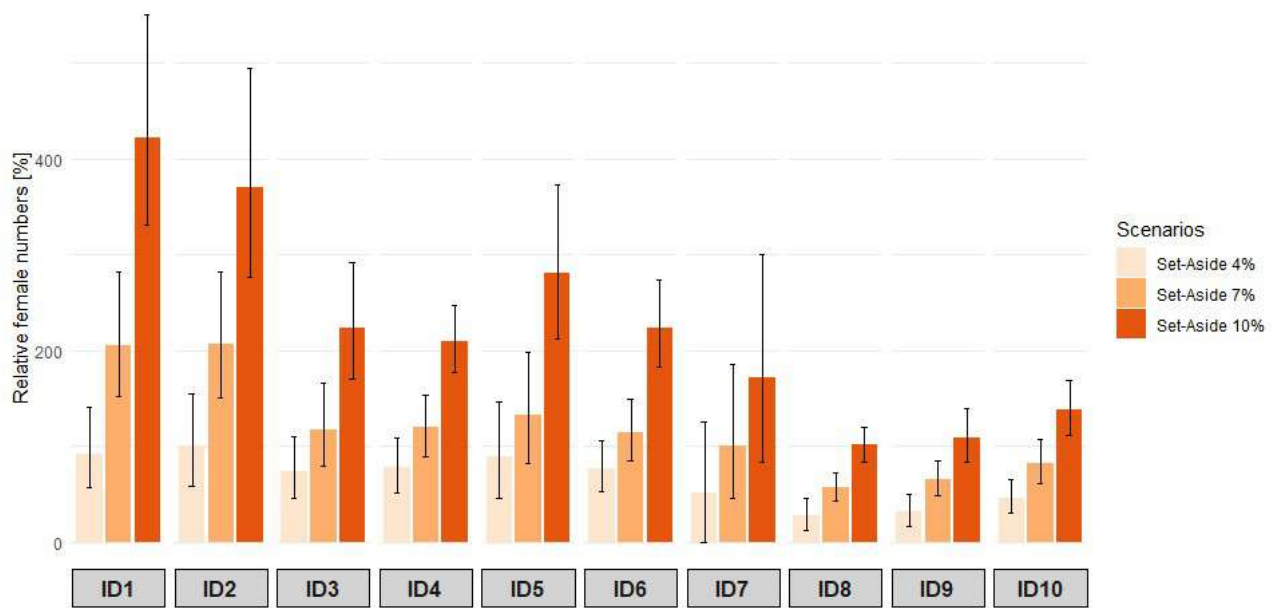


Figure 8.55 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

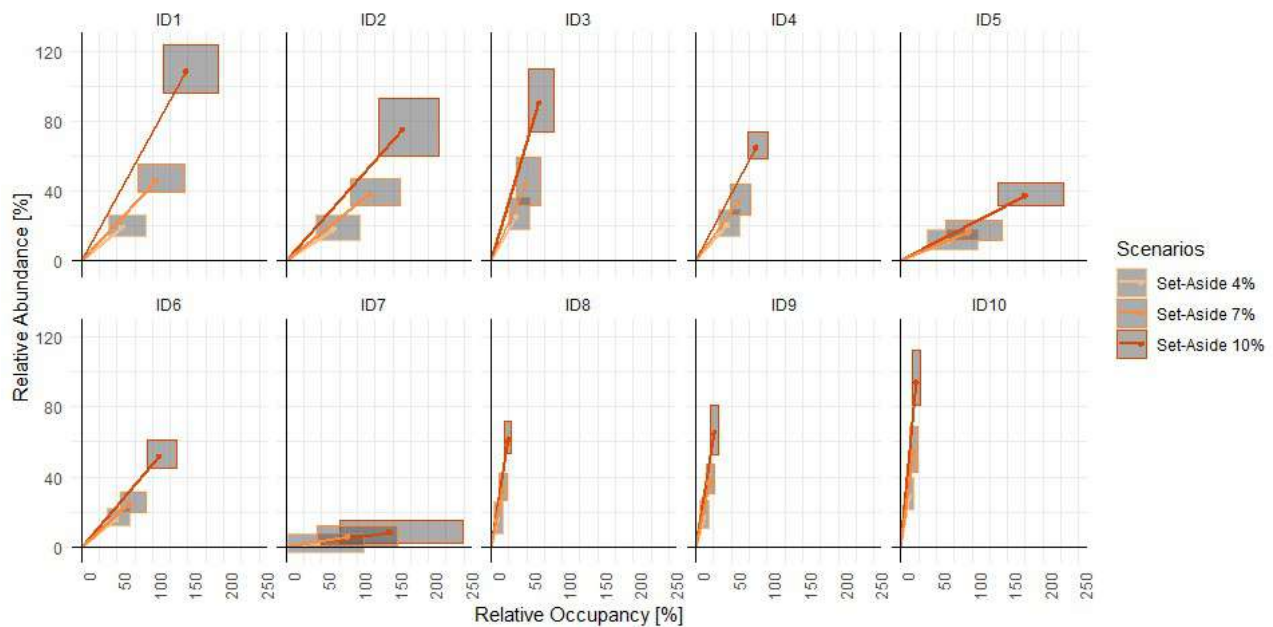


Figure 8.56 Setaside scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4.6 Legume

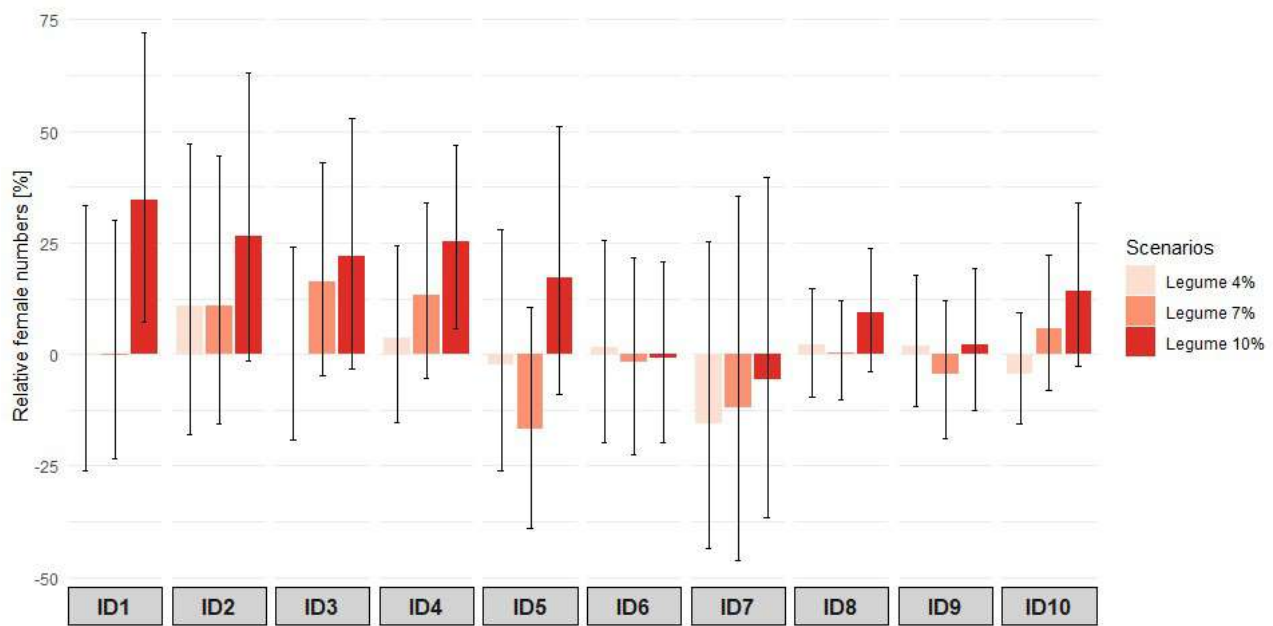


Figure 8.57 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

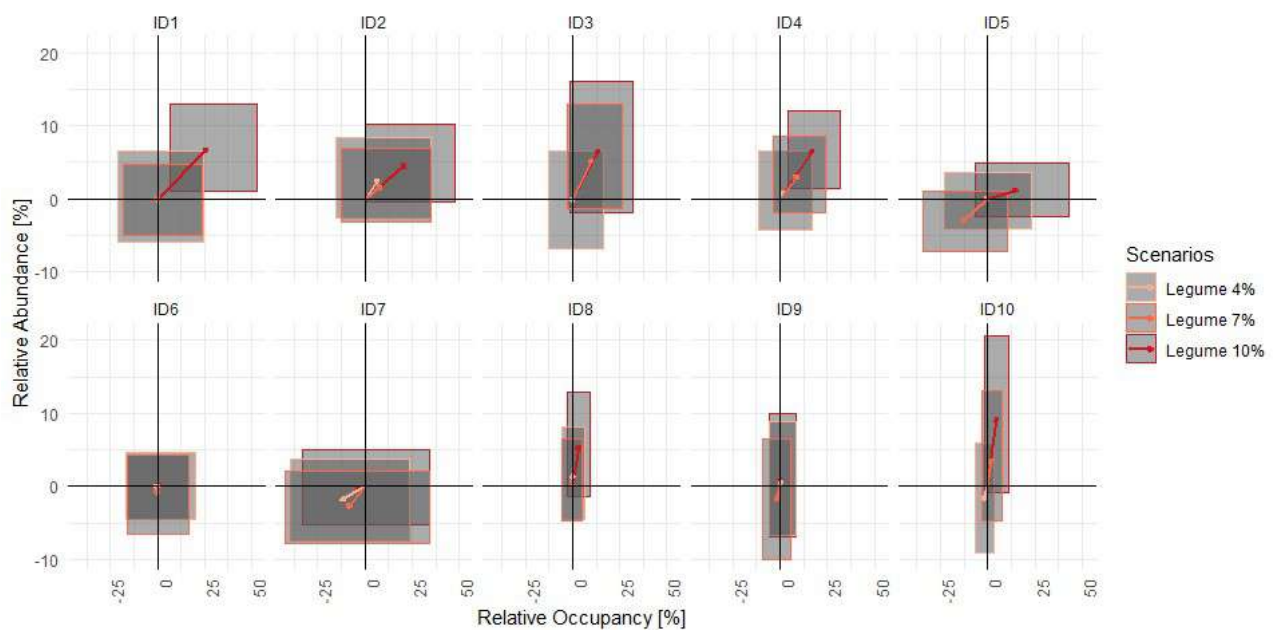


Figure 8.58 Legume scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.4.7 Biopesticides

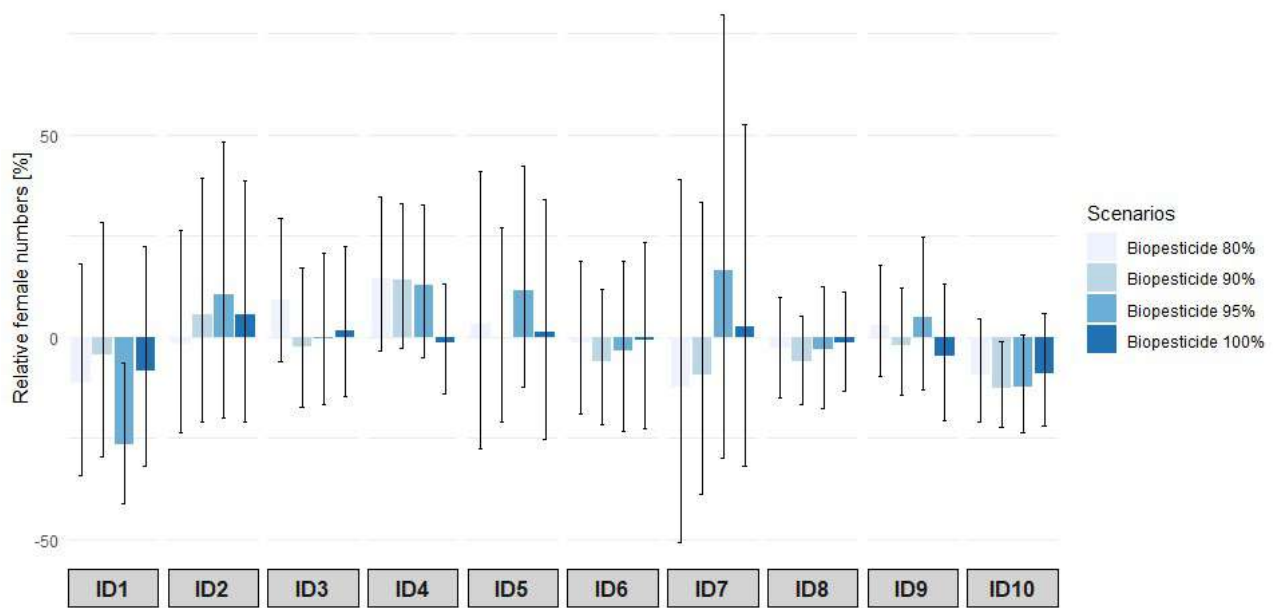


Figure 8.59 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Poland.

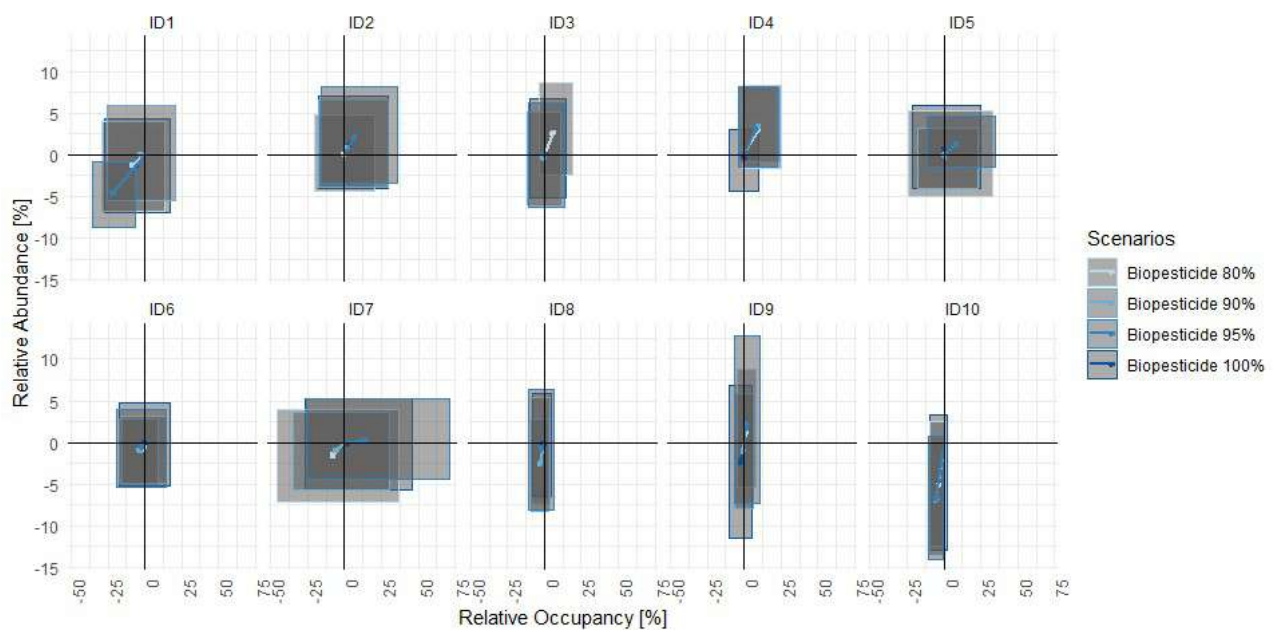


Figure 8.60 Biopesticide scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5 Finland

8.5.1 Flower field margins

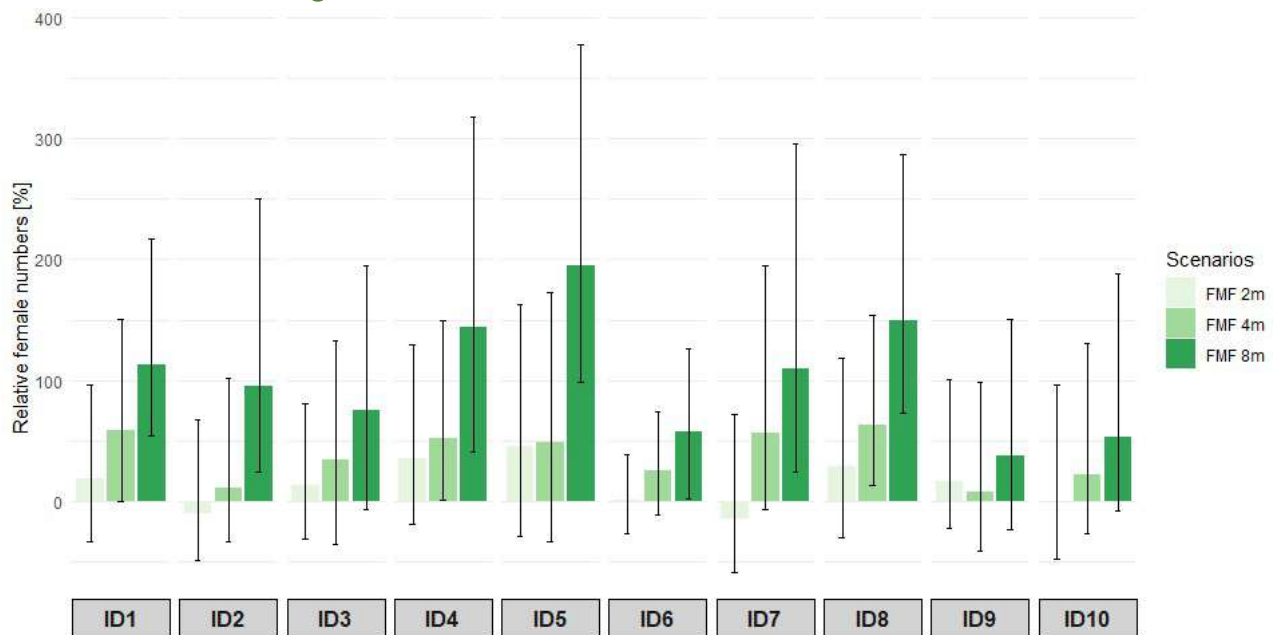


Figure 8.61 Flower field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

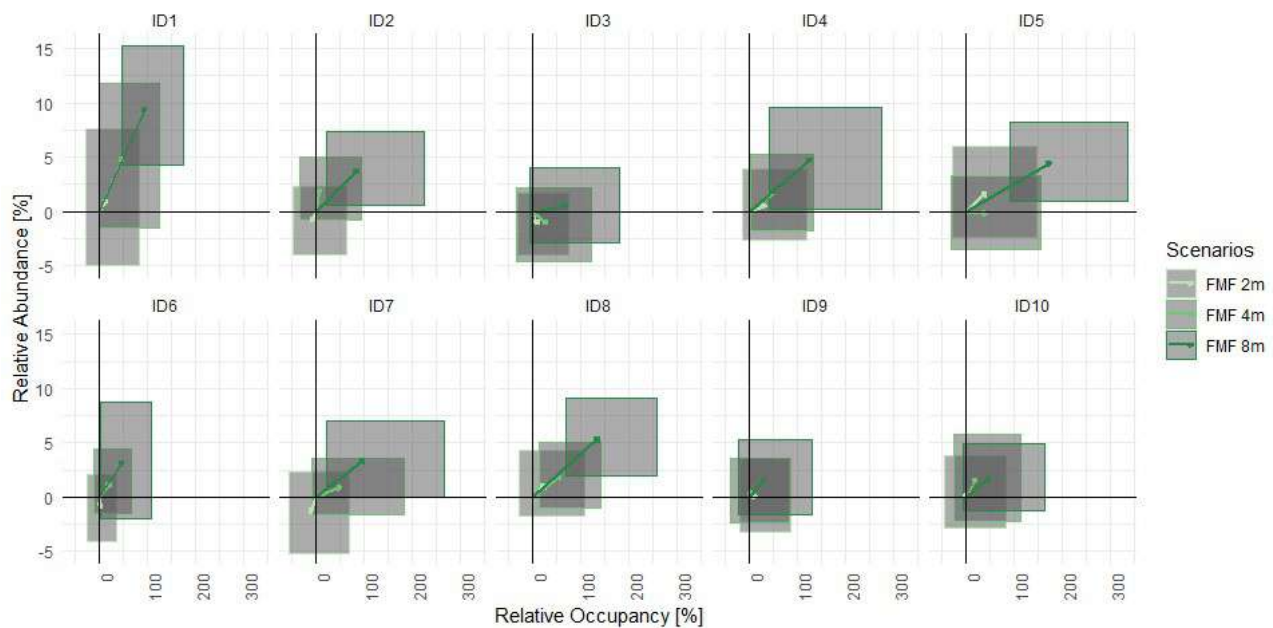


Figure 8.62 Flower field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5.2 Grassy field margins

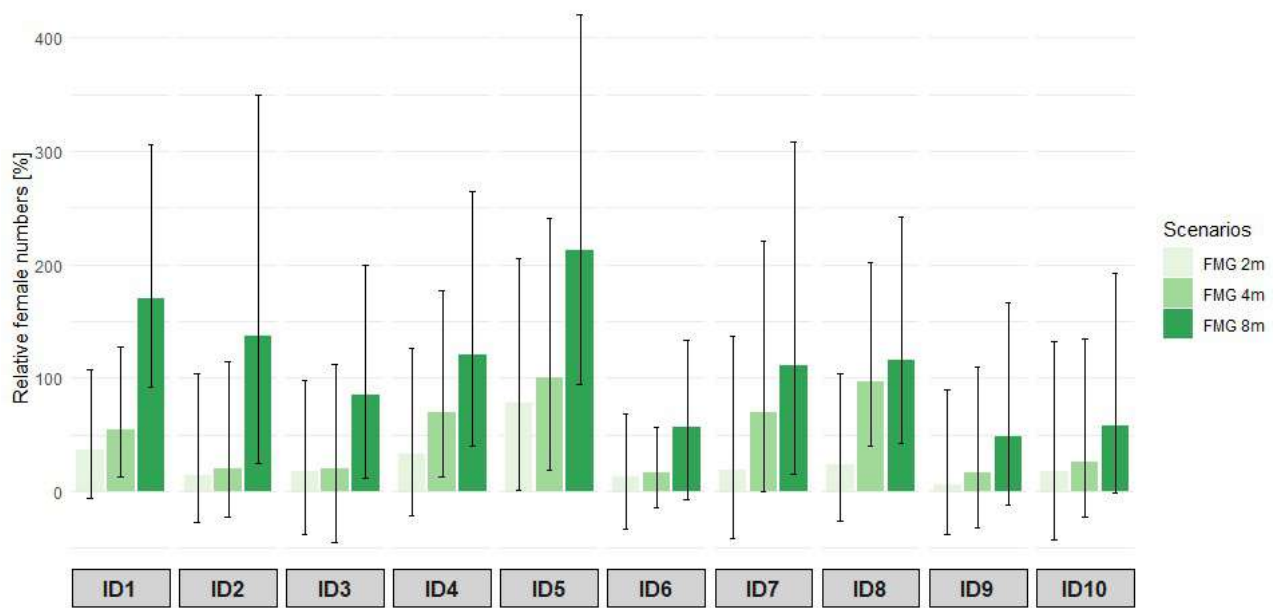


Figure 8.63 Grassy field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

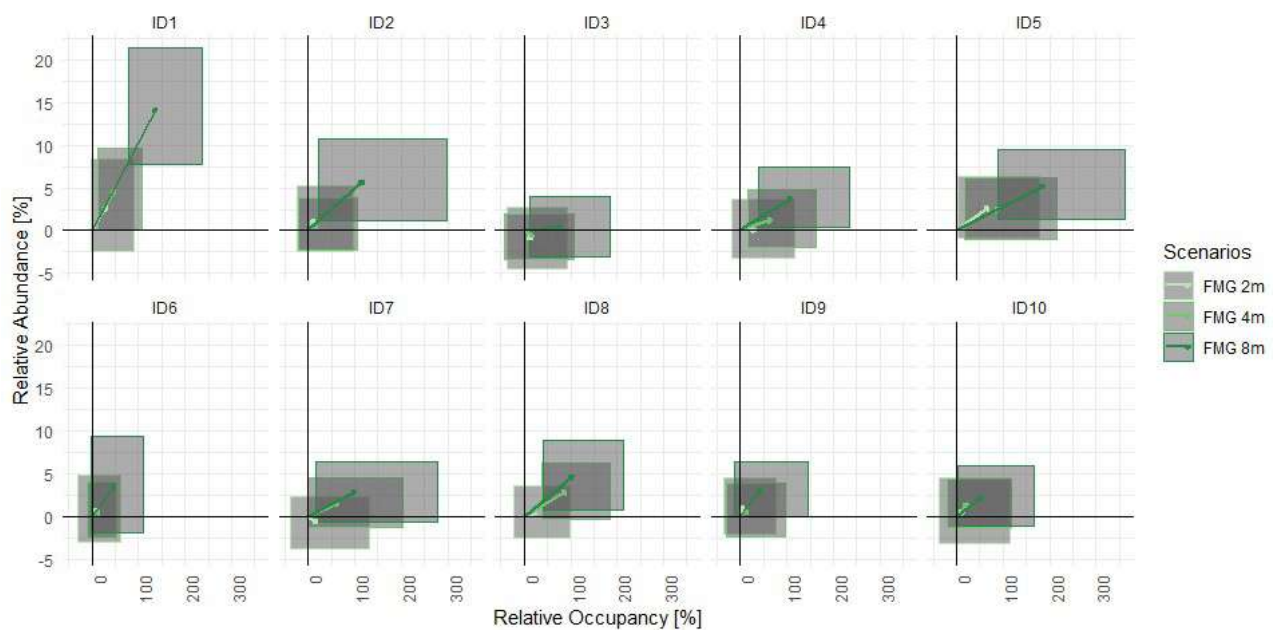


Figure 8.64 Grassy field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5.3 Mixed field margins

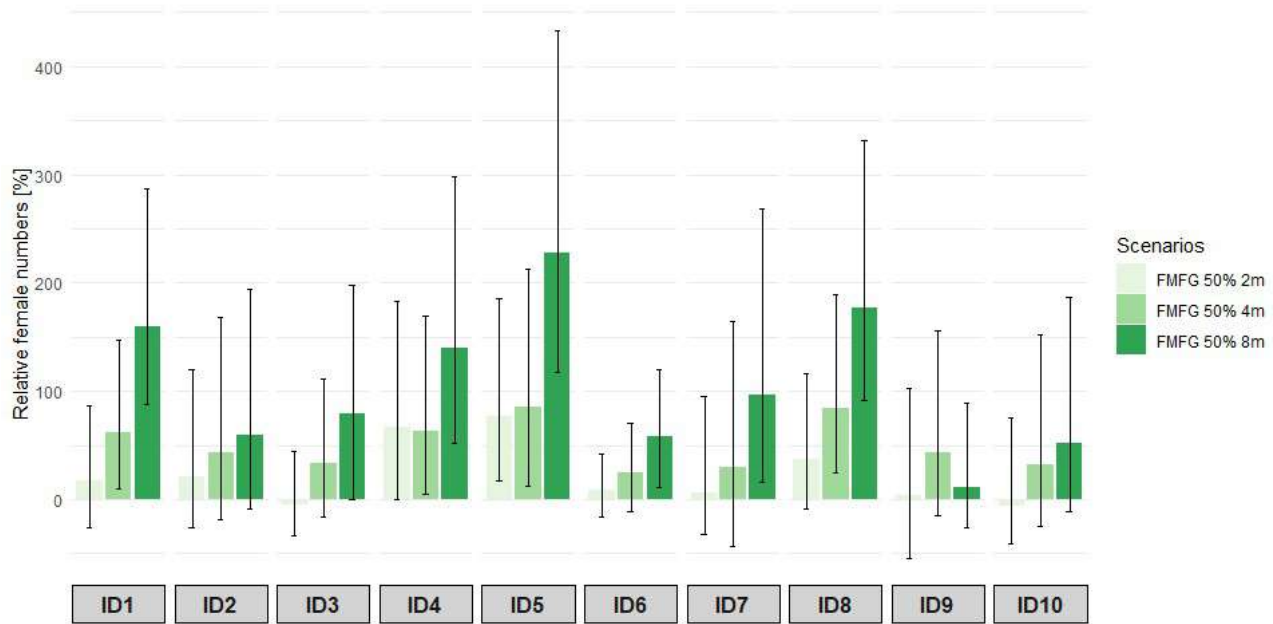


Figure 8.65 Mixed field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

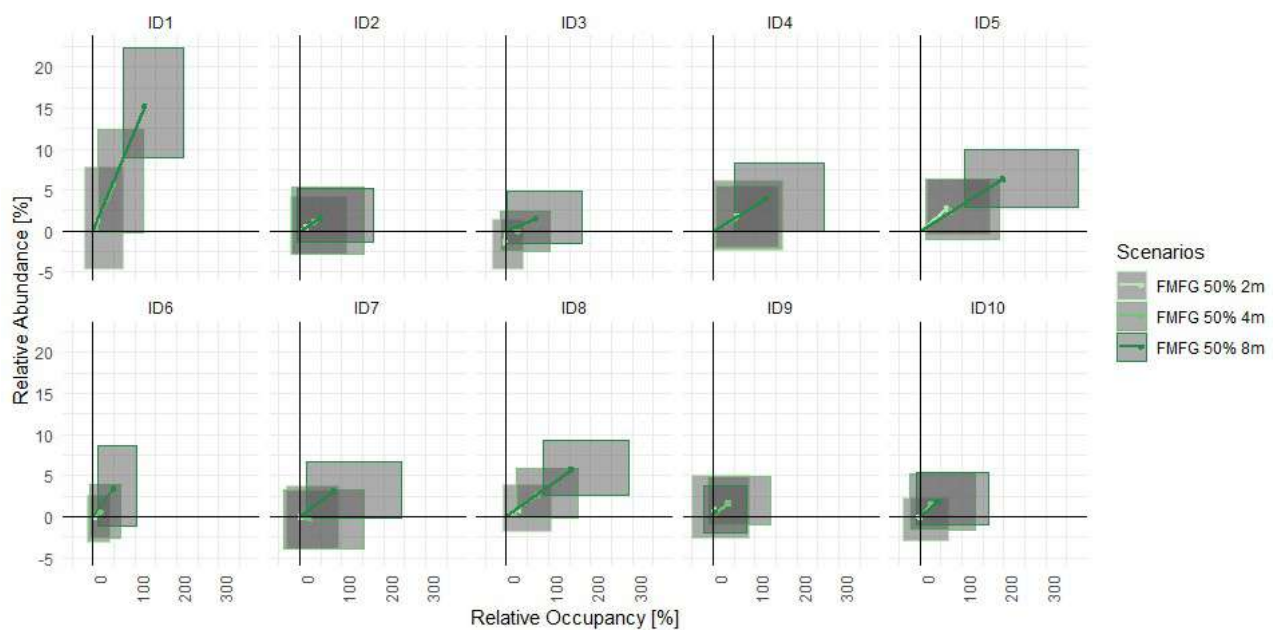


Figure 8.66 Mixed field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5.4 Flower, grassy and mixed field margins

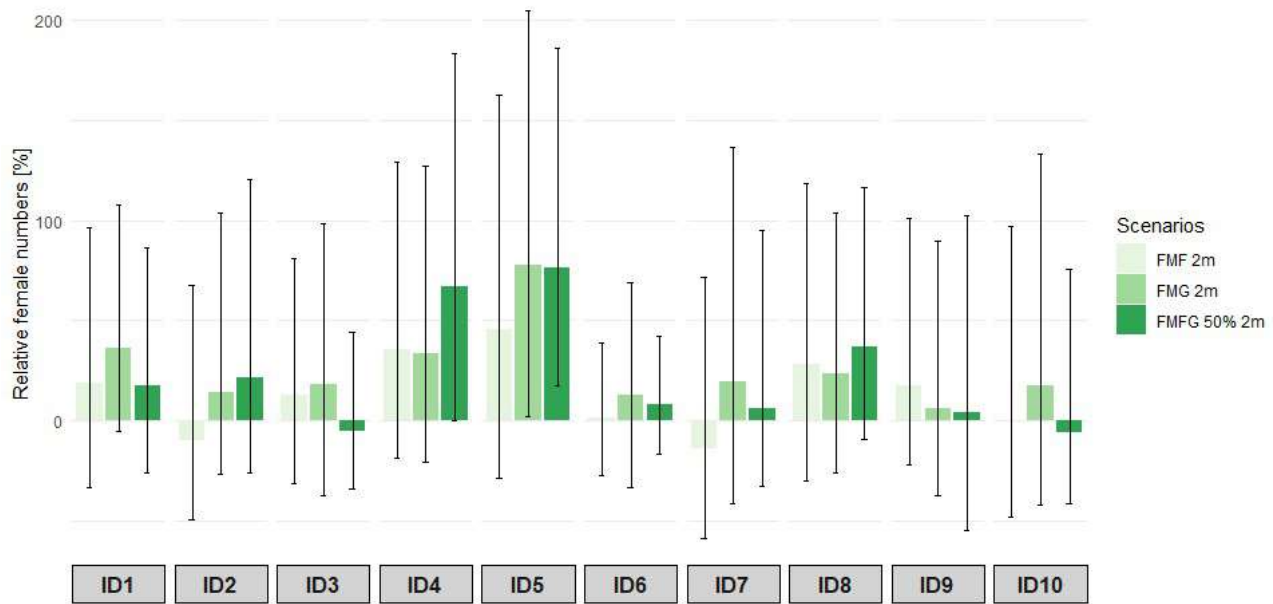


Figure 8.67 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

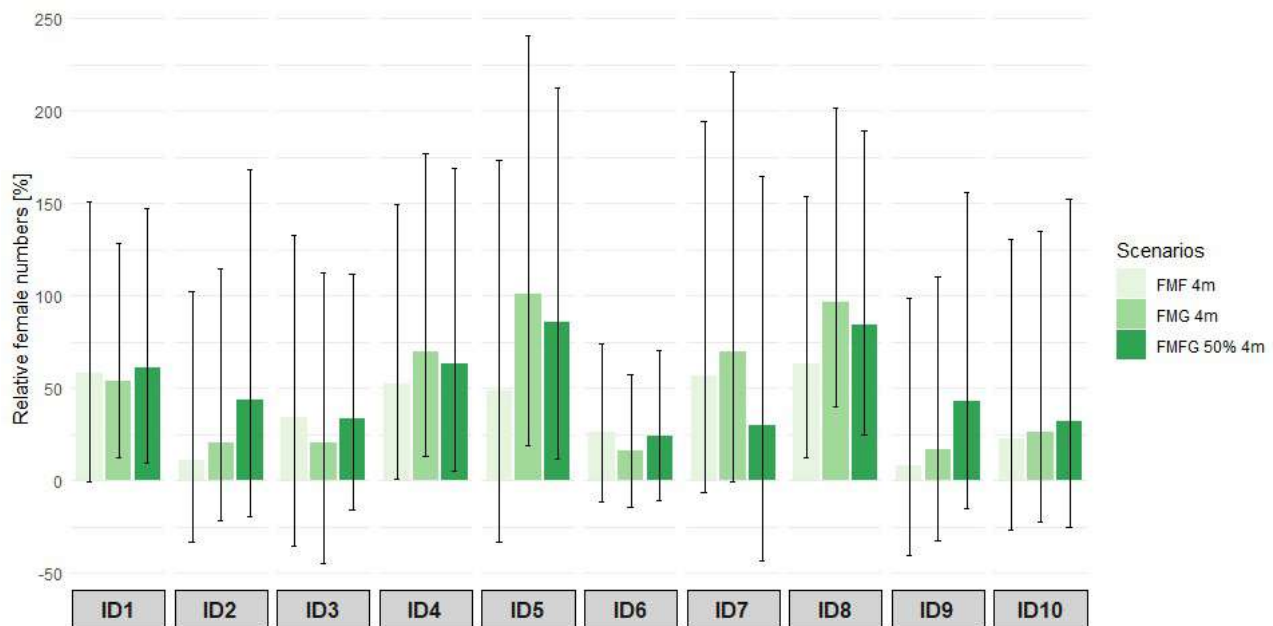


Figure 8.68 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

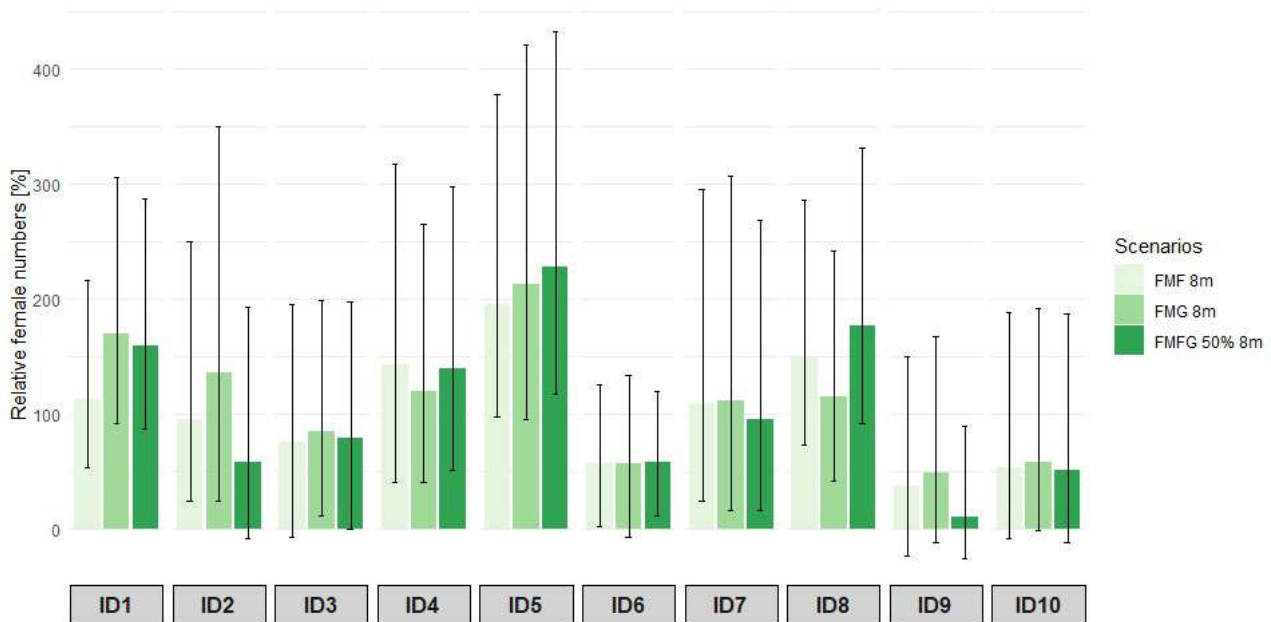


Figure 8.69 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

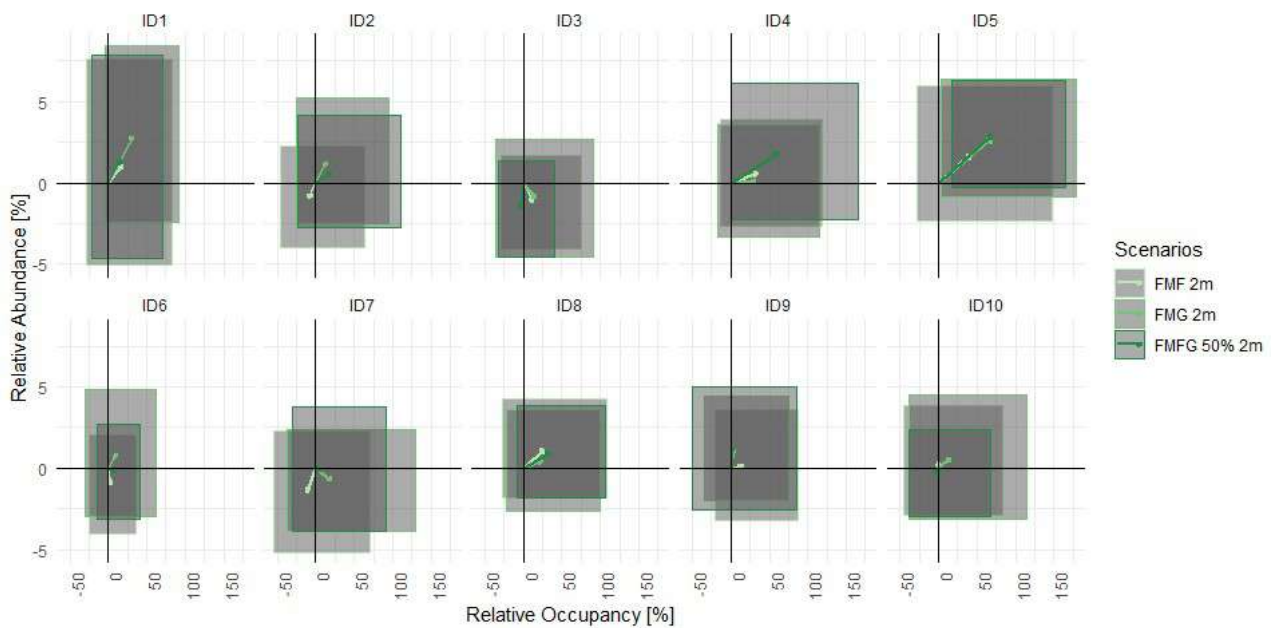


Figure 8.70 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

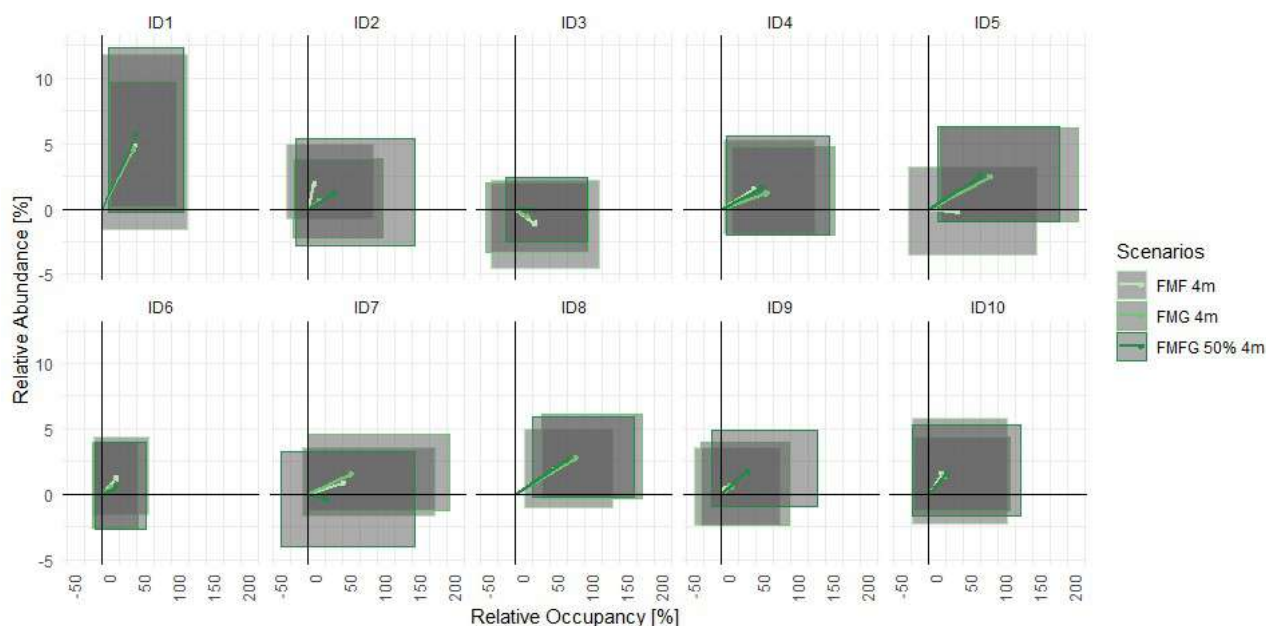


Figure 8.71 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes..

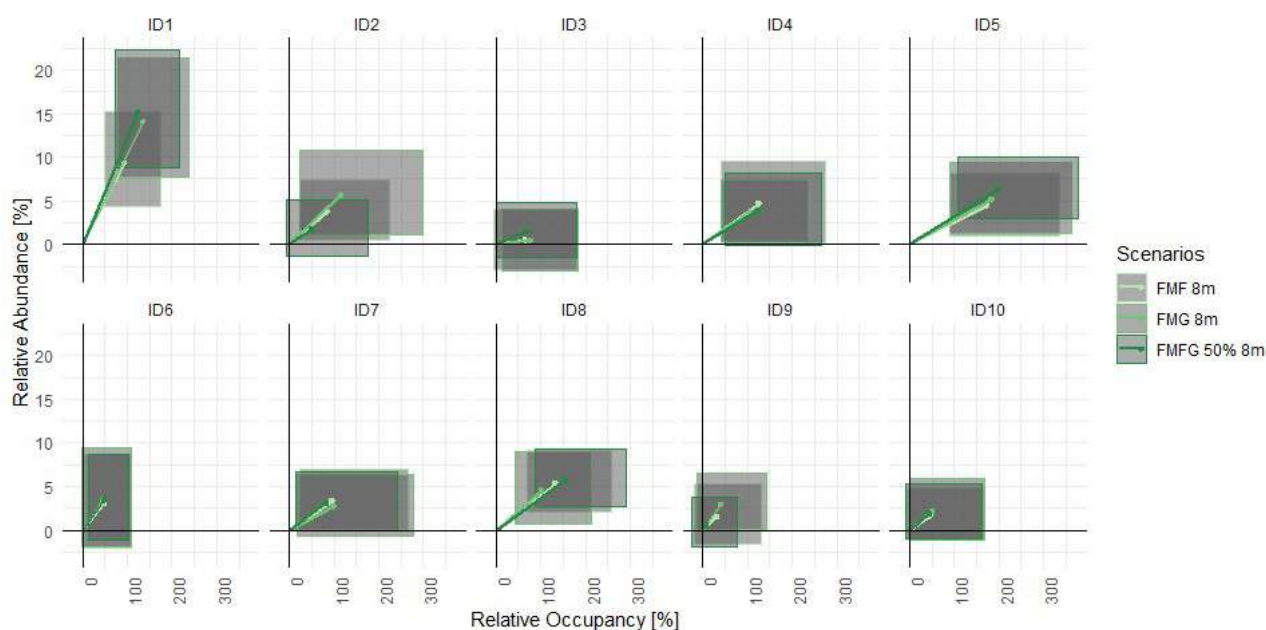


Figure 8.72 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5.5 Setaside

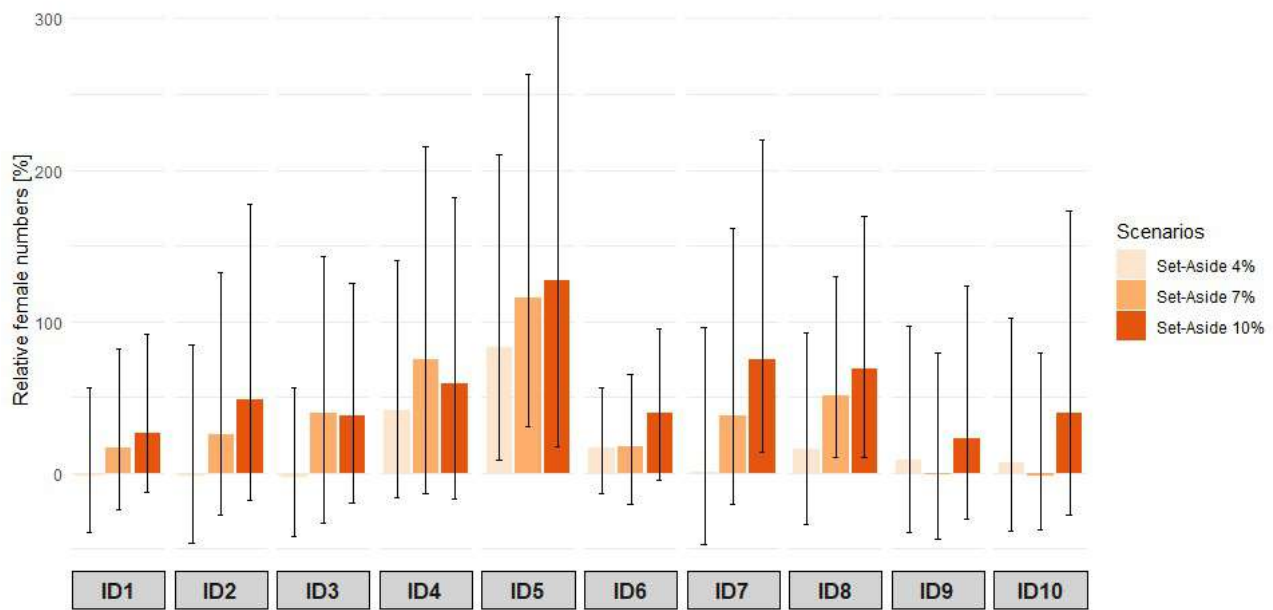


Figure 8.73 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

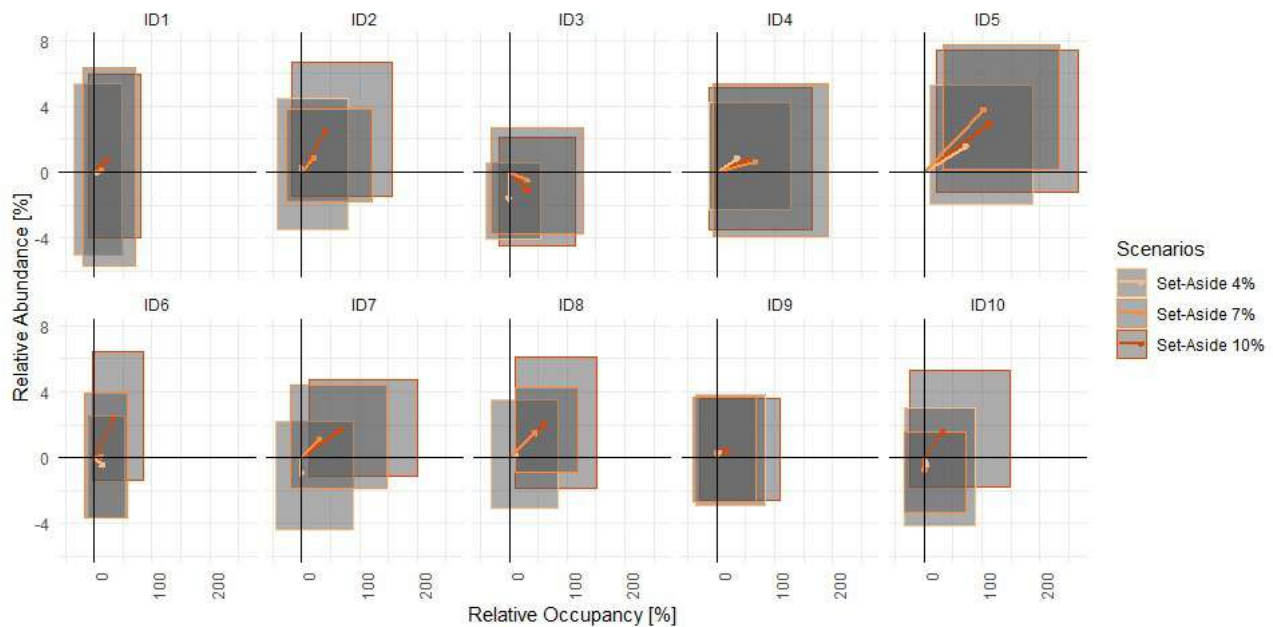


Figure 8.74 Setaside scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5.6 Legume

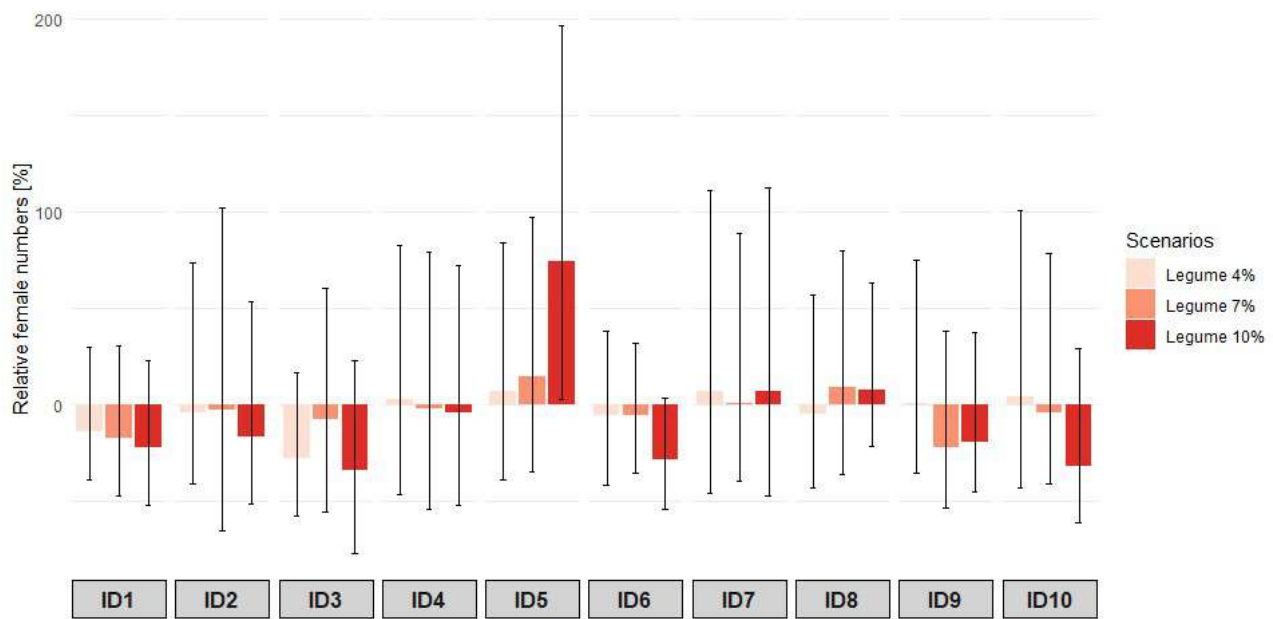


Figure 8.75 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

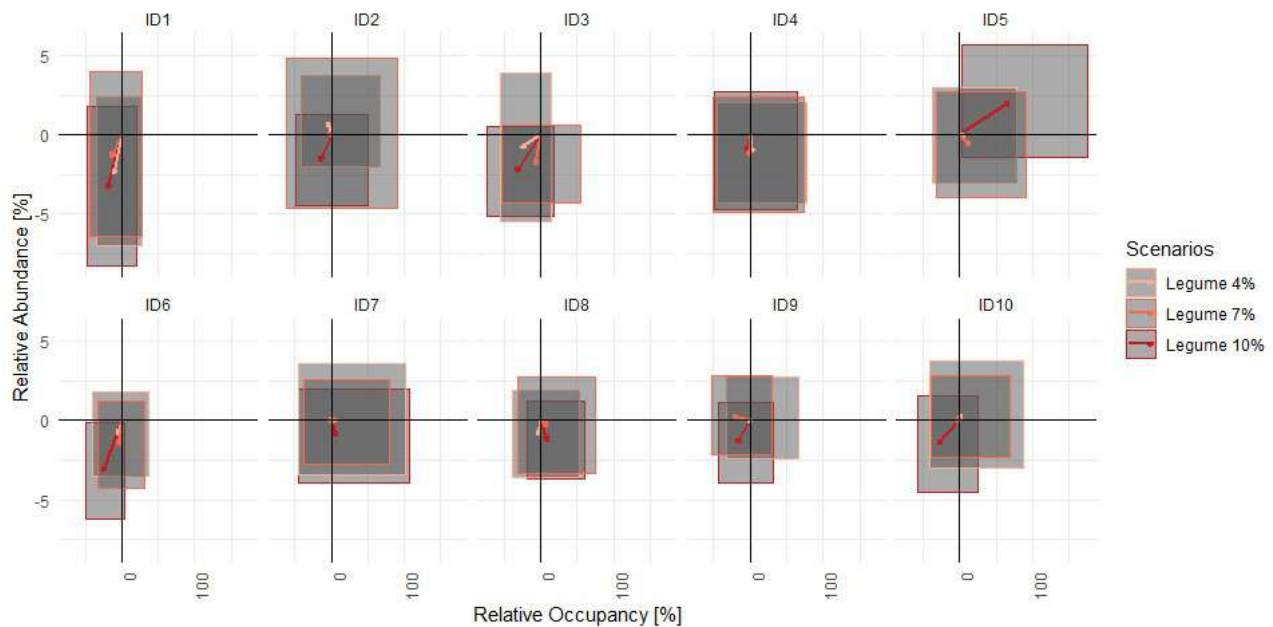


Figure 8.76 Legume scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.5.7 Biopesticides

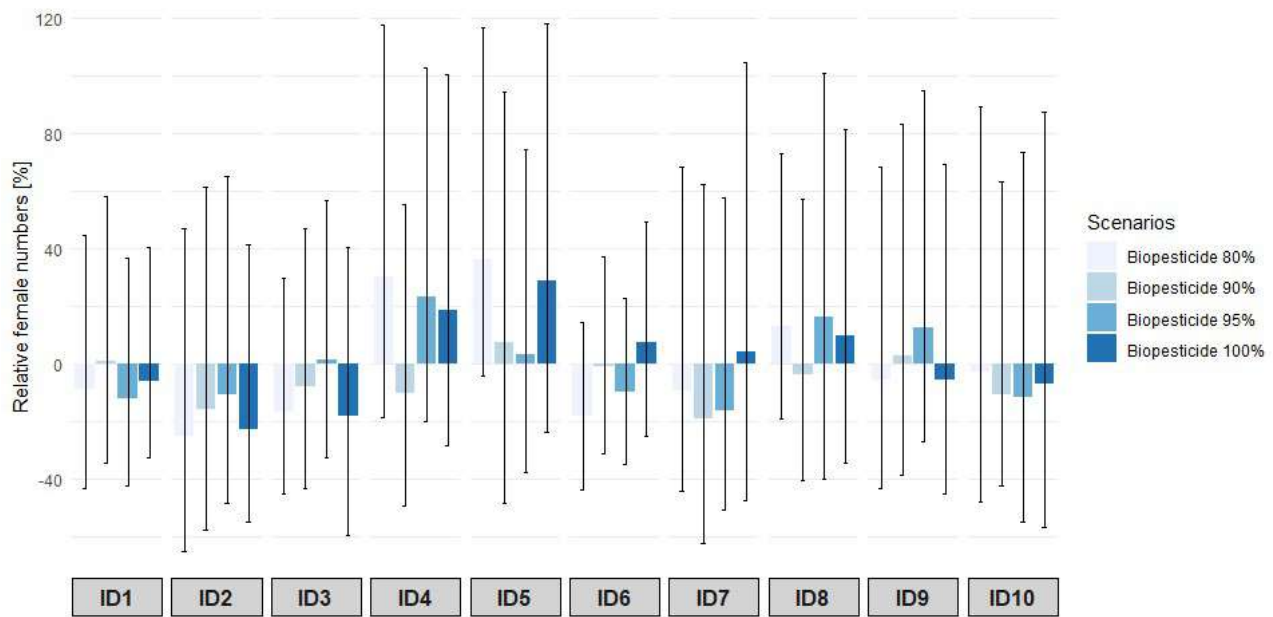


Figure 8.77 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in Finland.

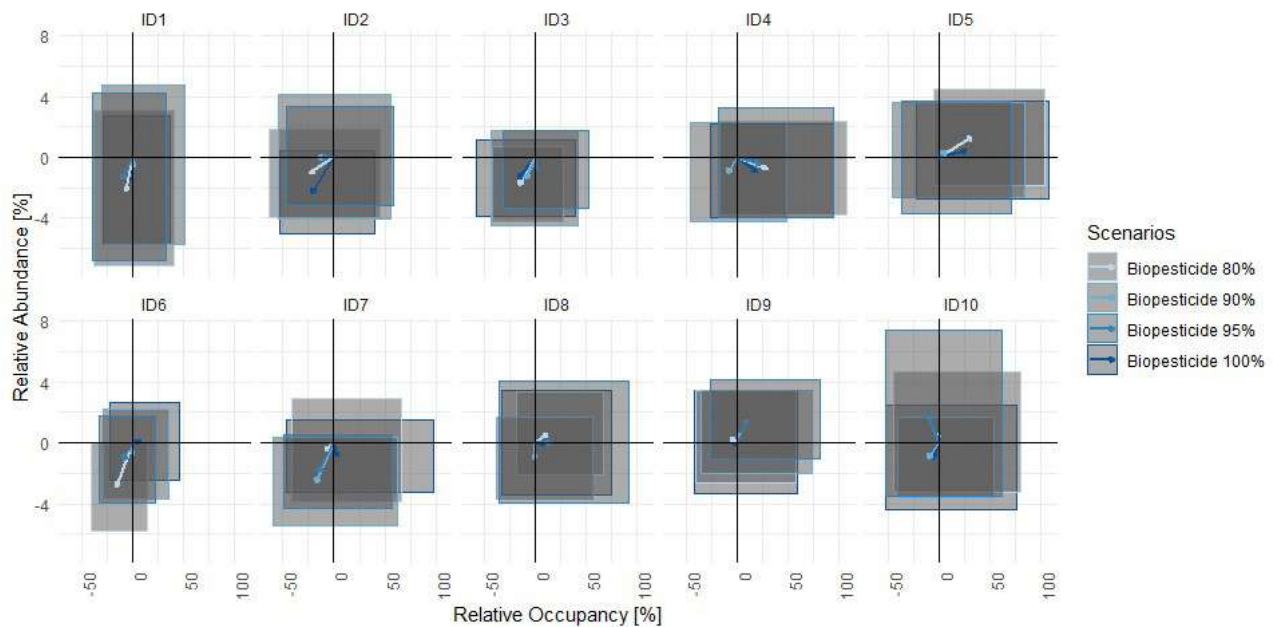


Figure 8.78 Biopesticide scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6 France

8.6.1 Flower field margins

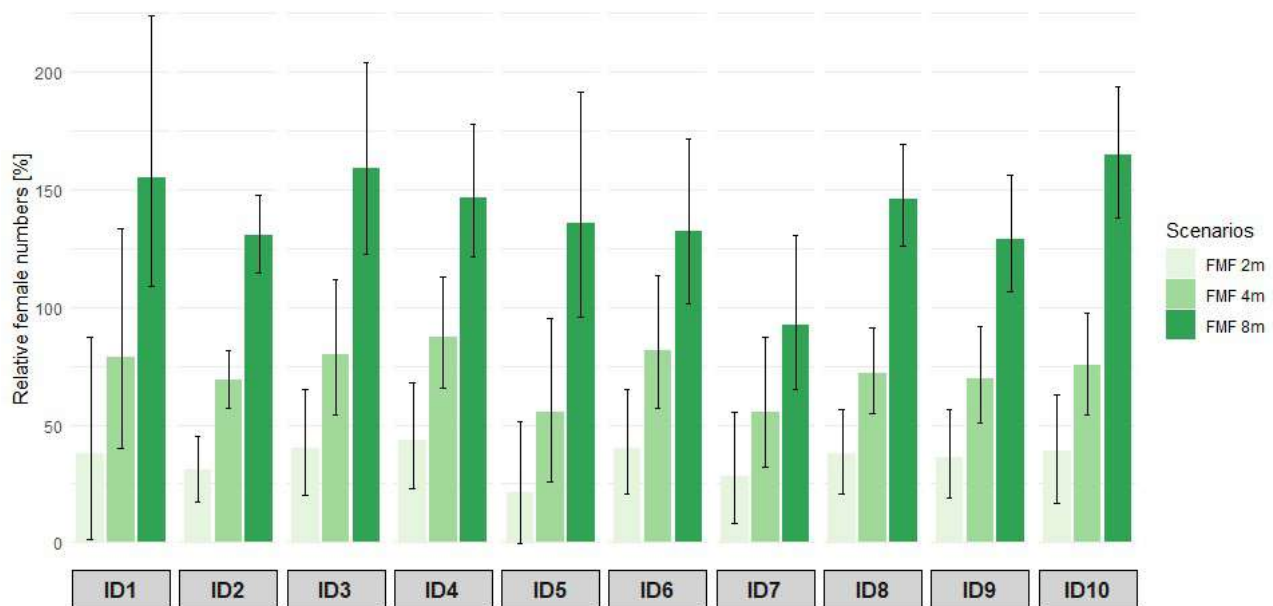


Figure 8.79 Flower field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

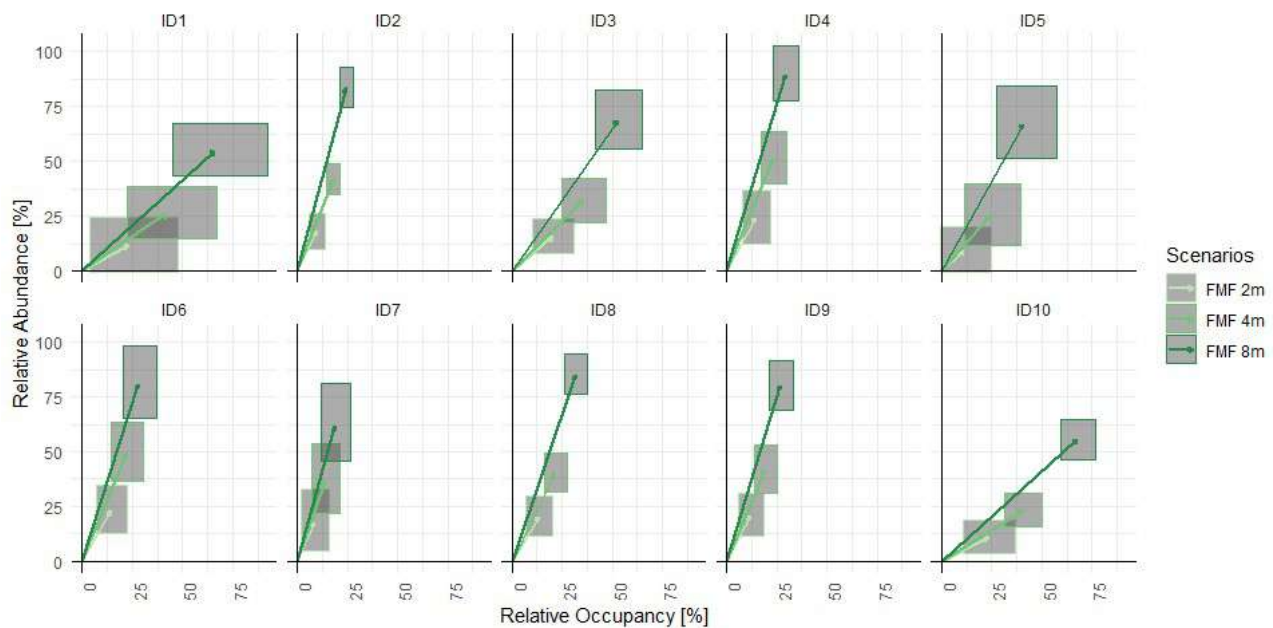


Figure 8.80 Flower field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6.2 Grassy field margins

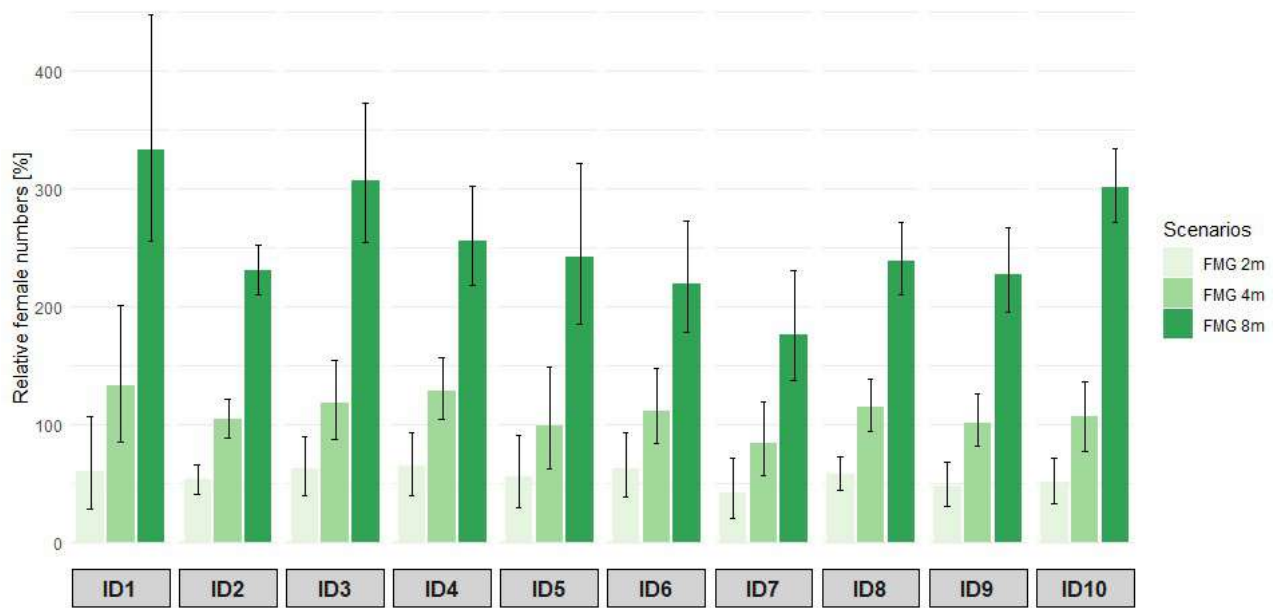


Figure 8.81 Grassy field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

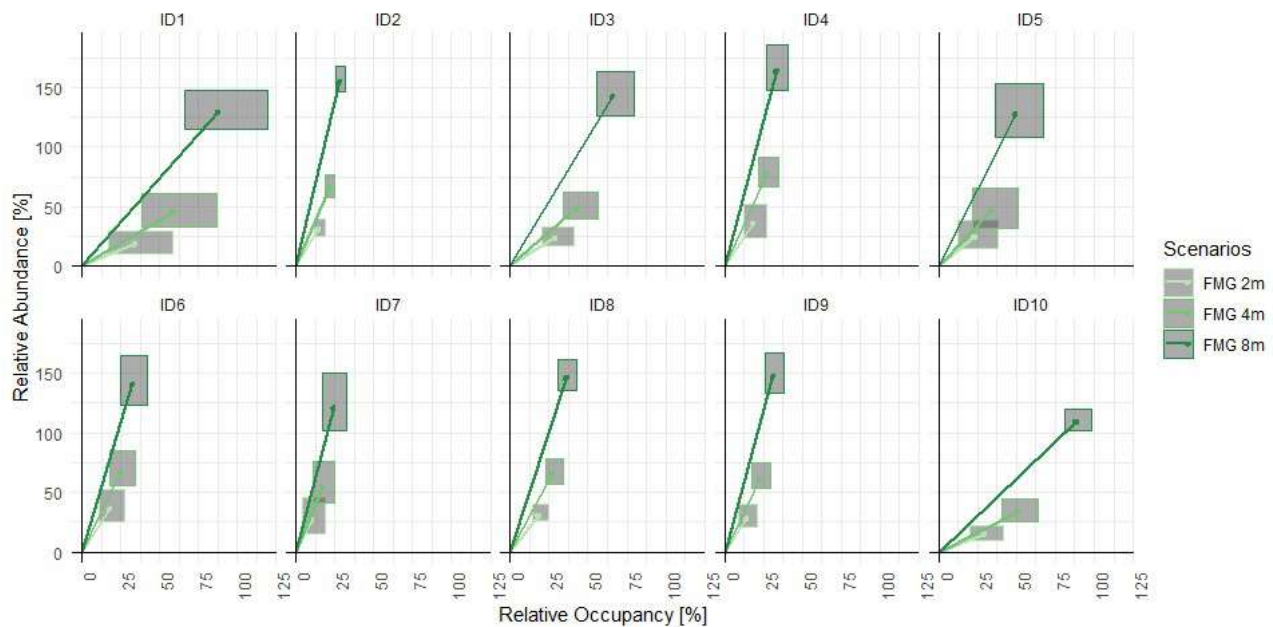


Figure 8.82 Grassy field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6.3 Mixed field margins

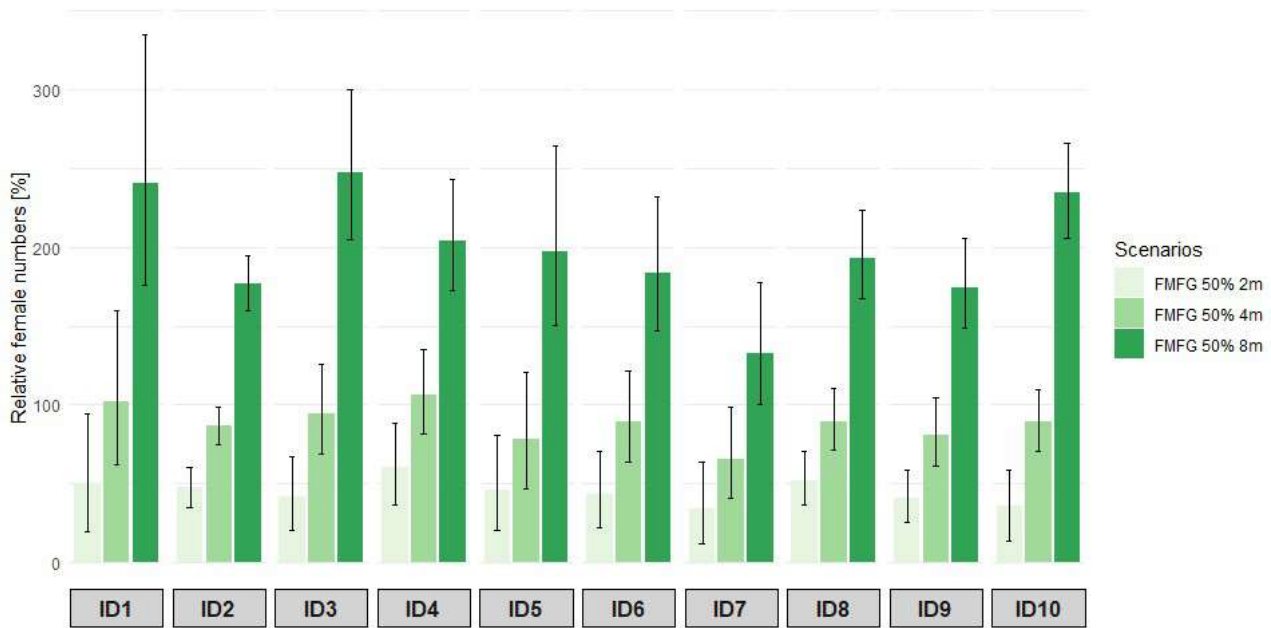


Figure 8.83 Mixed field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

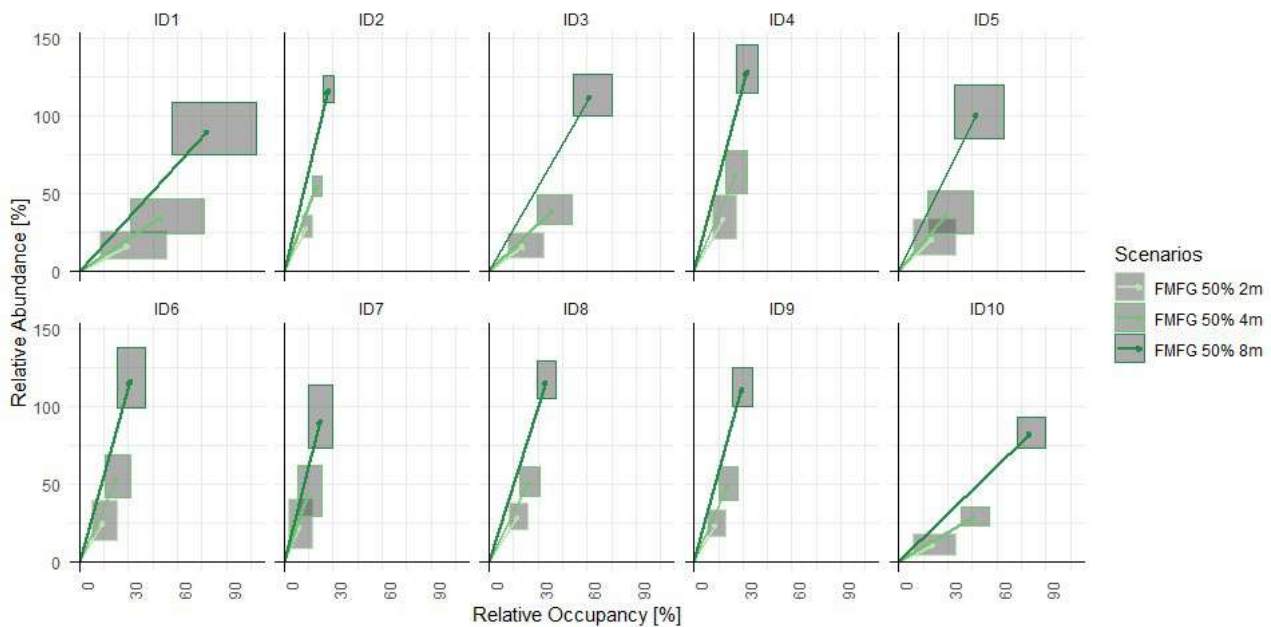


Figure 8.84 Mixed field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6.4 Flower, grassy and mixed field margins

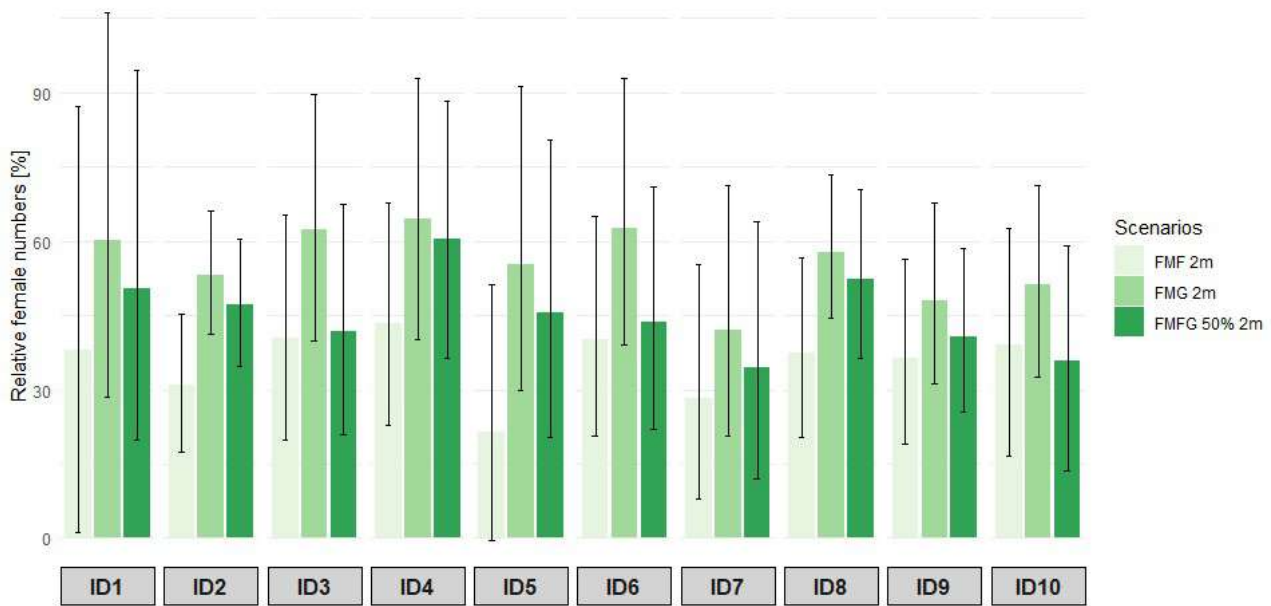


Figure 8.85 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

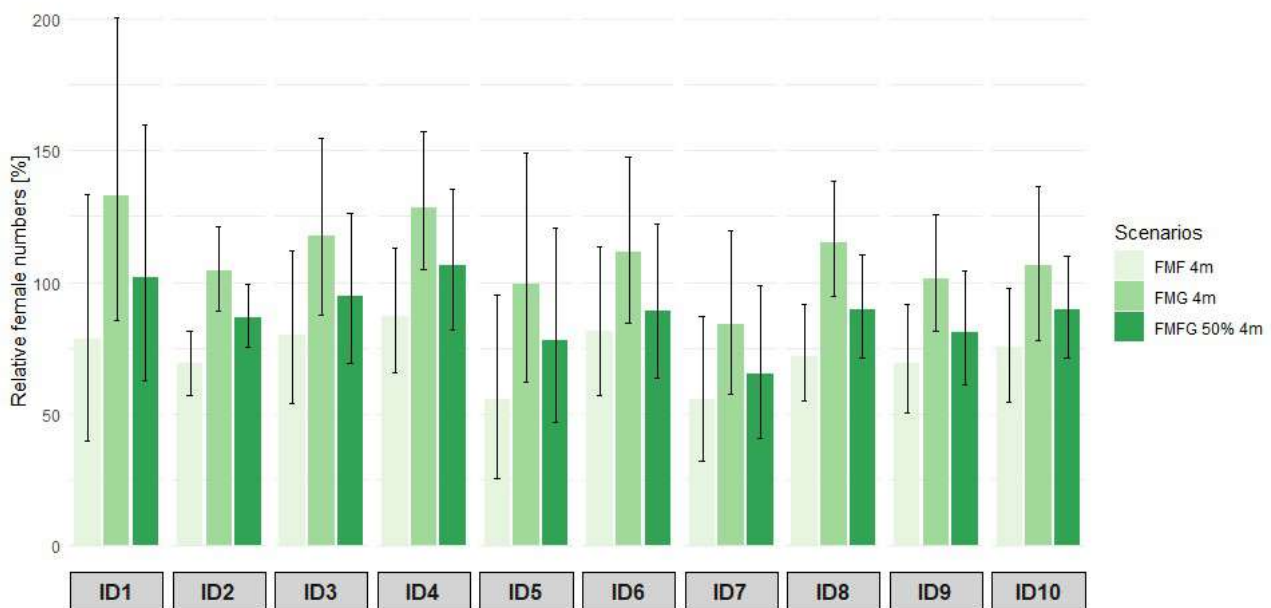


Figure 8.86 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

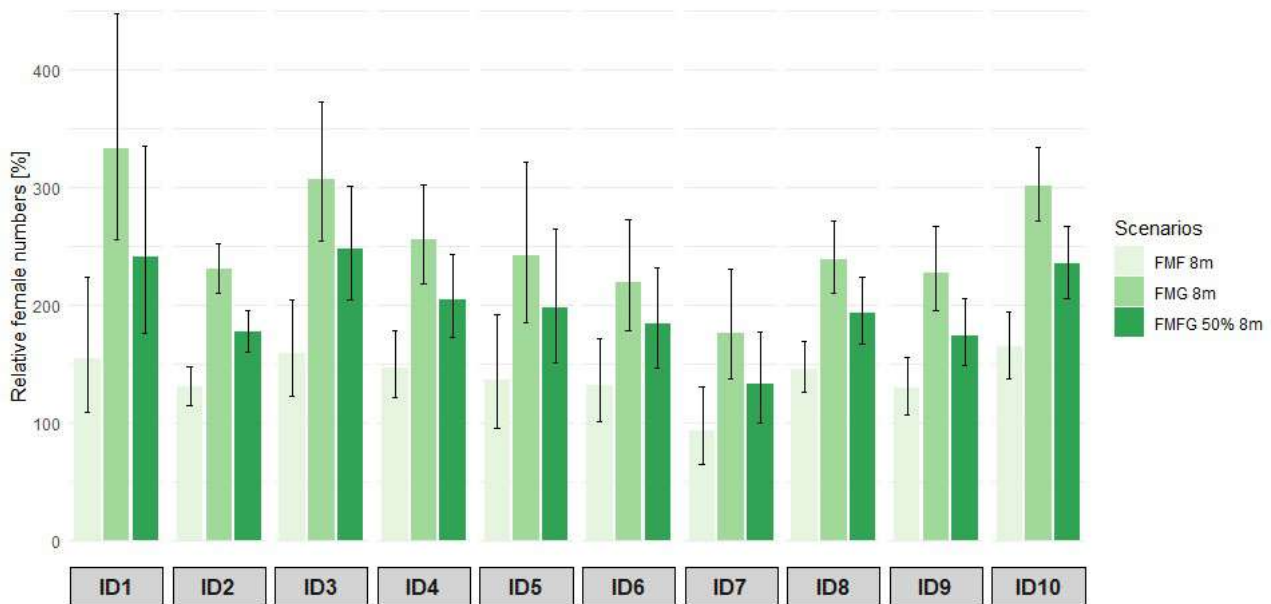


Figure 8.87 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

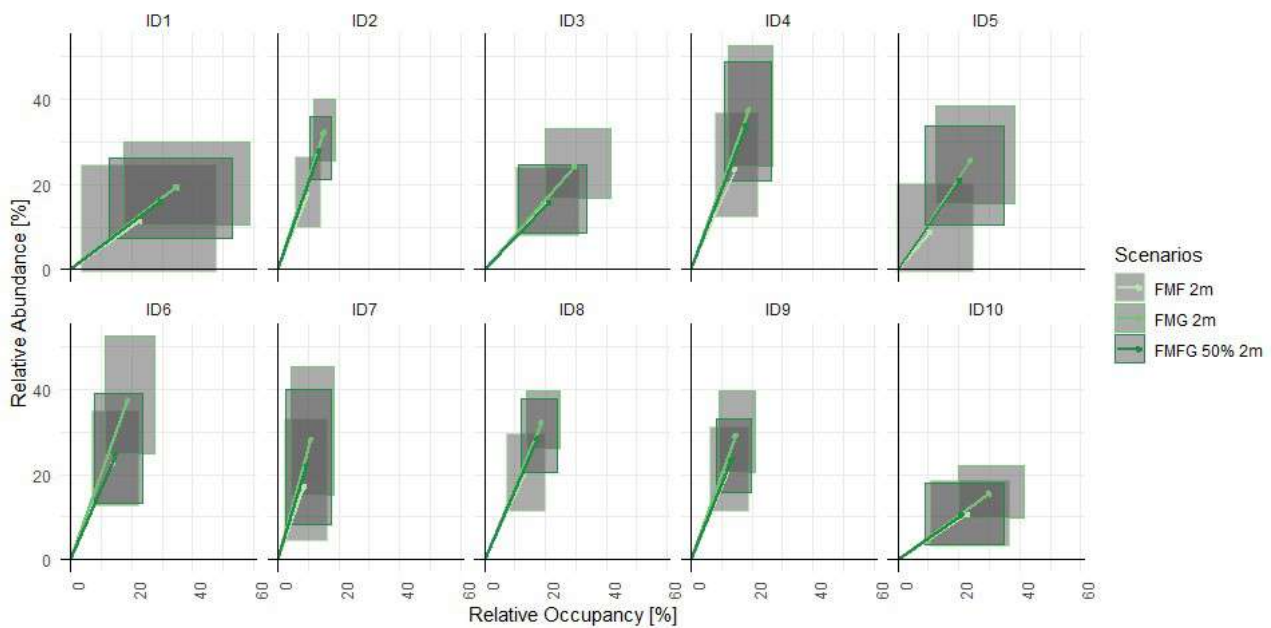


Figure 8.88 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

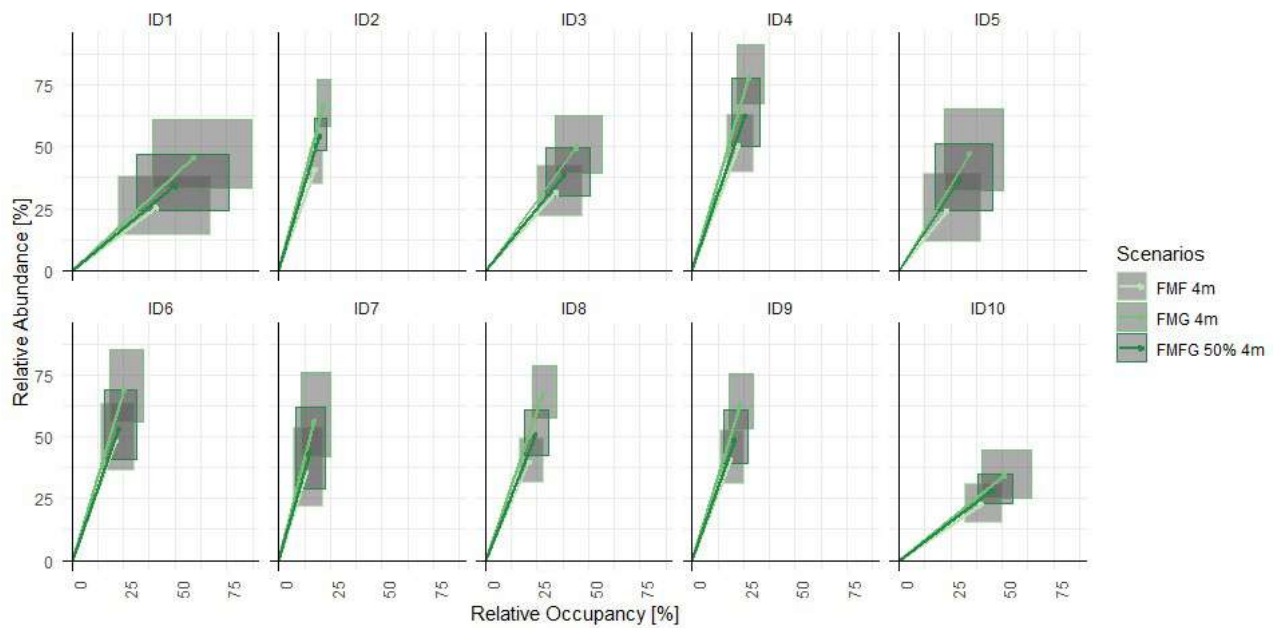


Figure 8.89 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes..

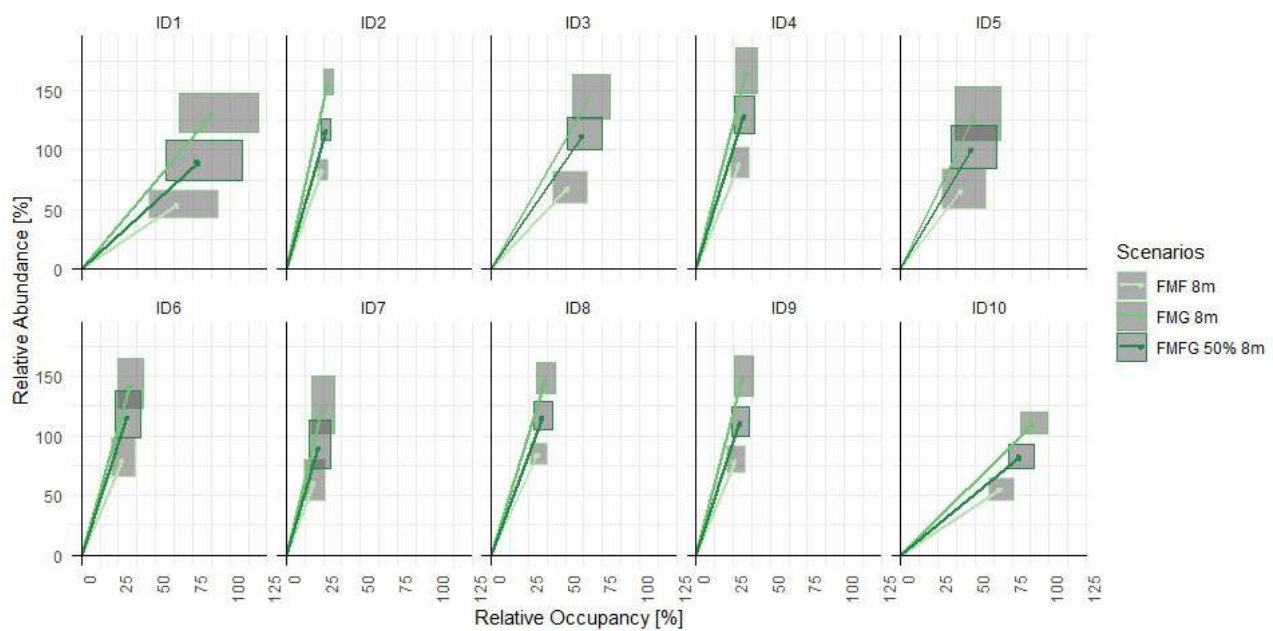


Figure 8.90 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6.5 Setaside

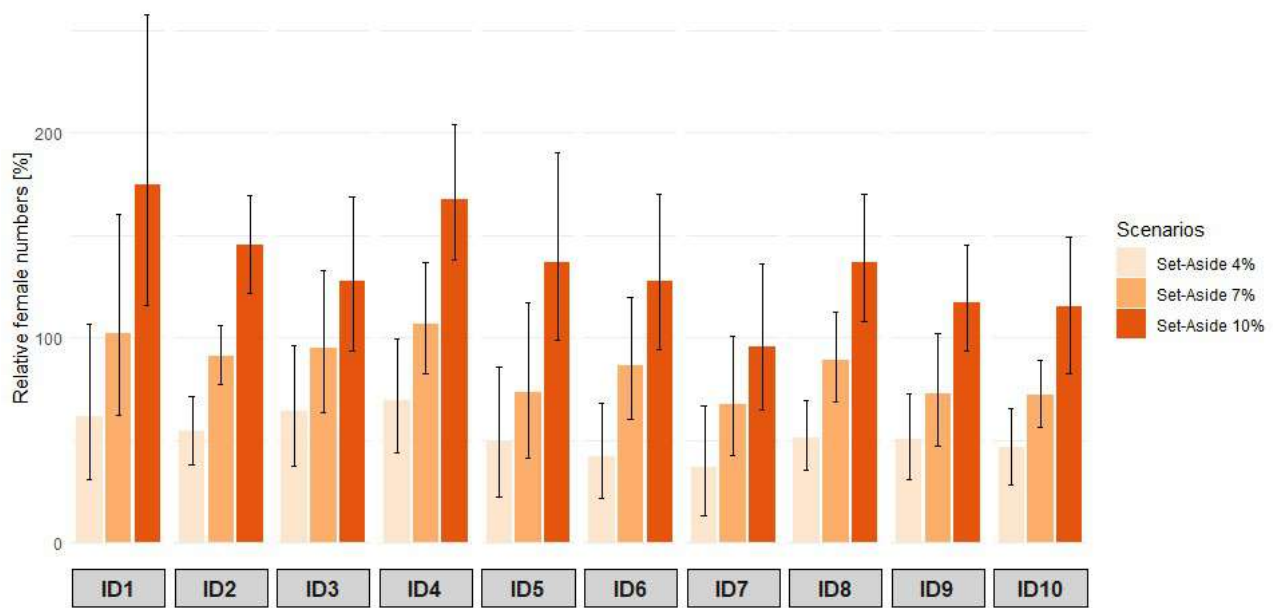


Figure 8.91 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

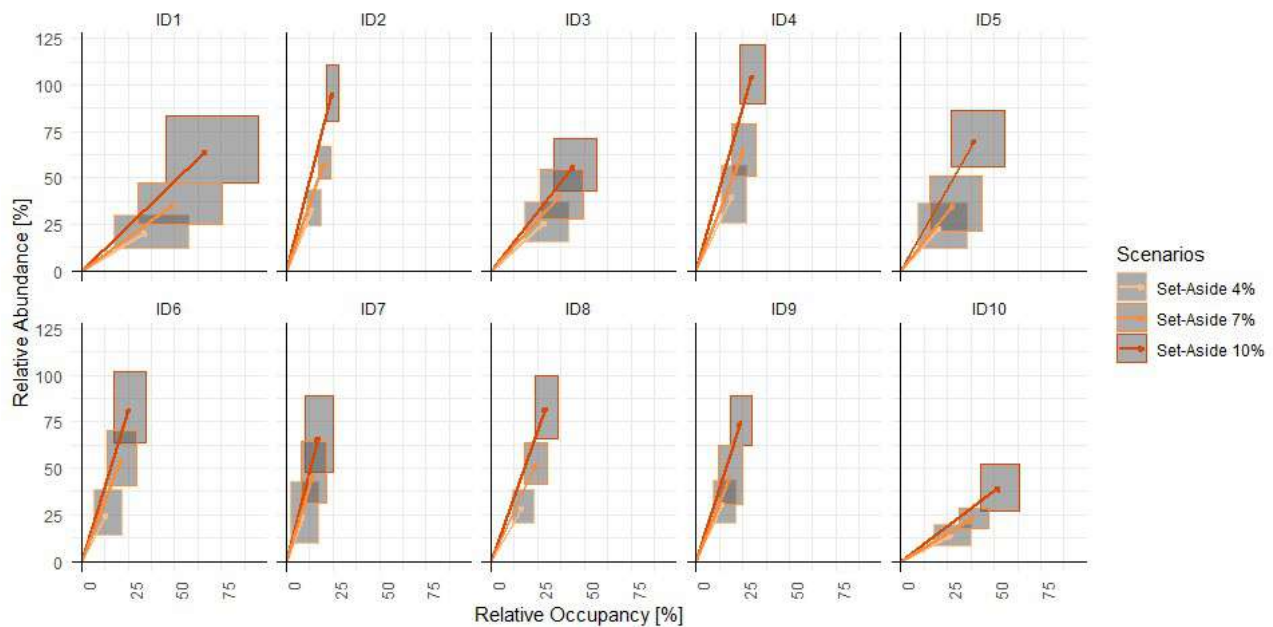


Figure 8.92 Setaside scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6.6 Legume

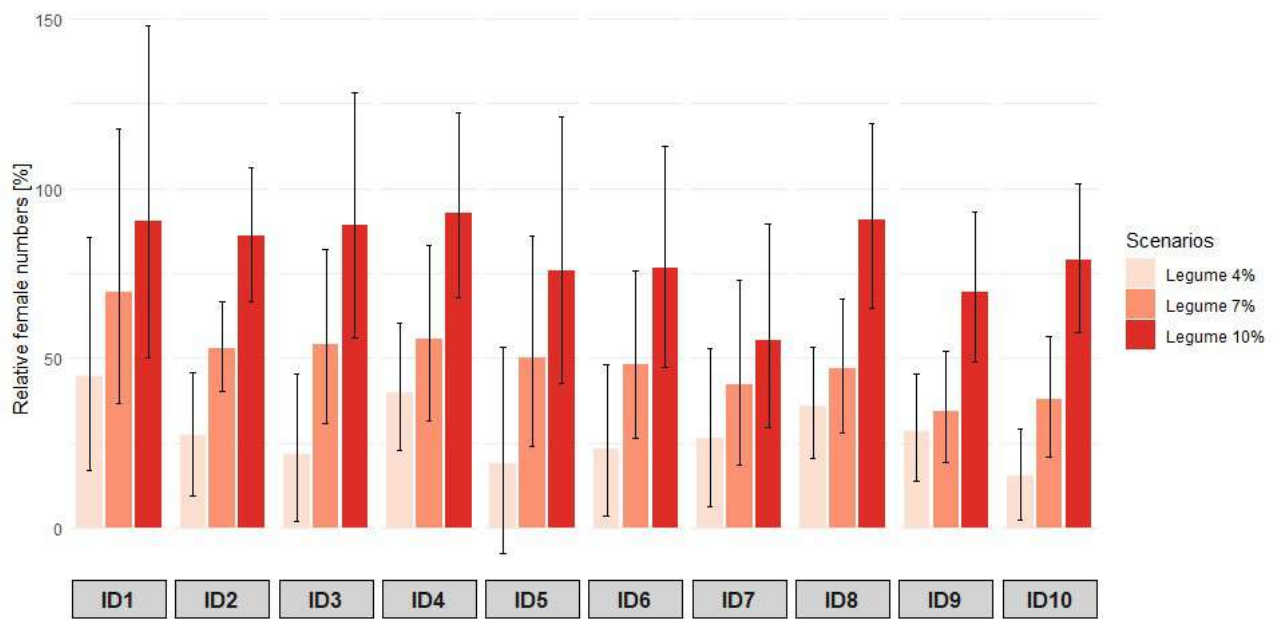


Figure 8.93 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

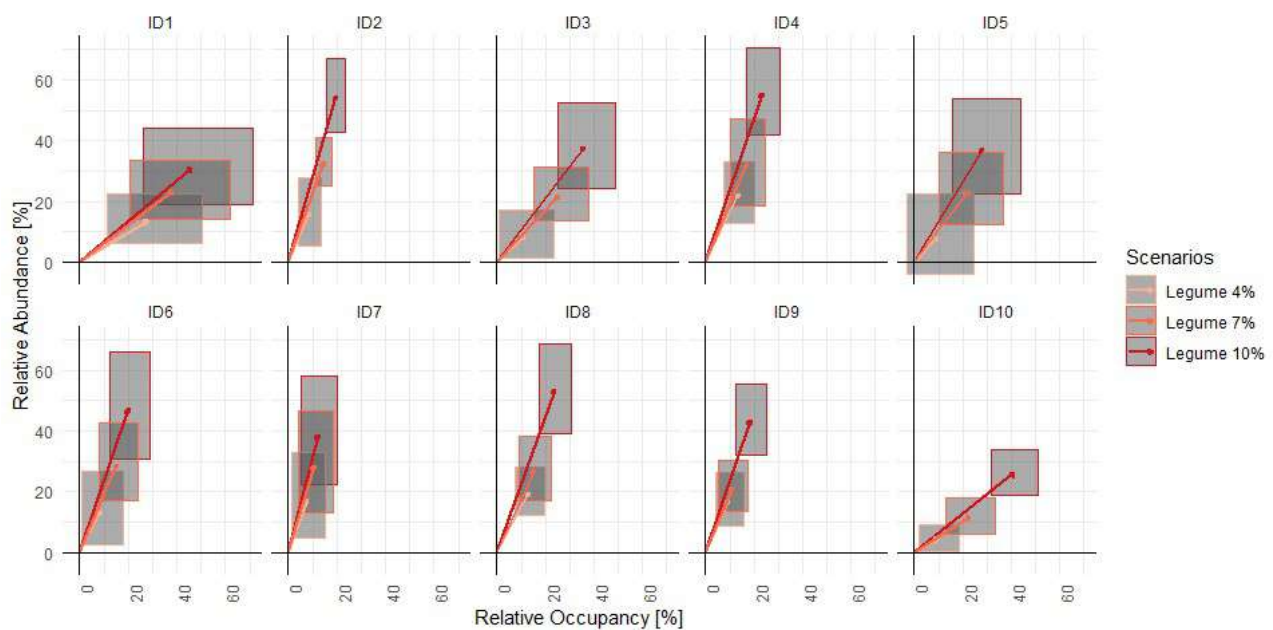


Figure 8.94 Legume scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.6.7 Biopesticides

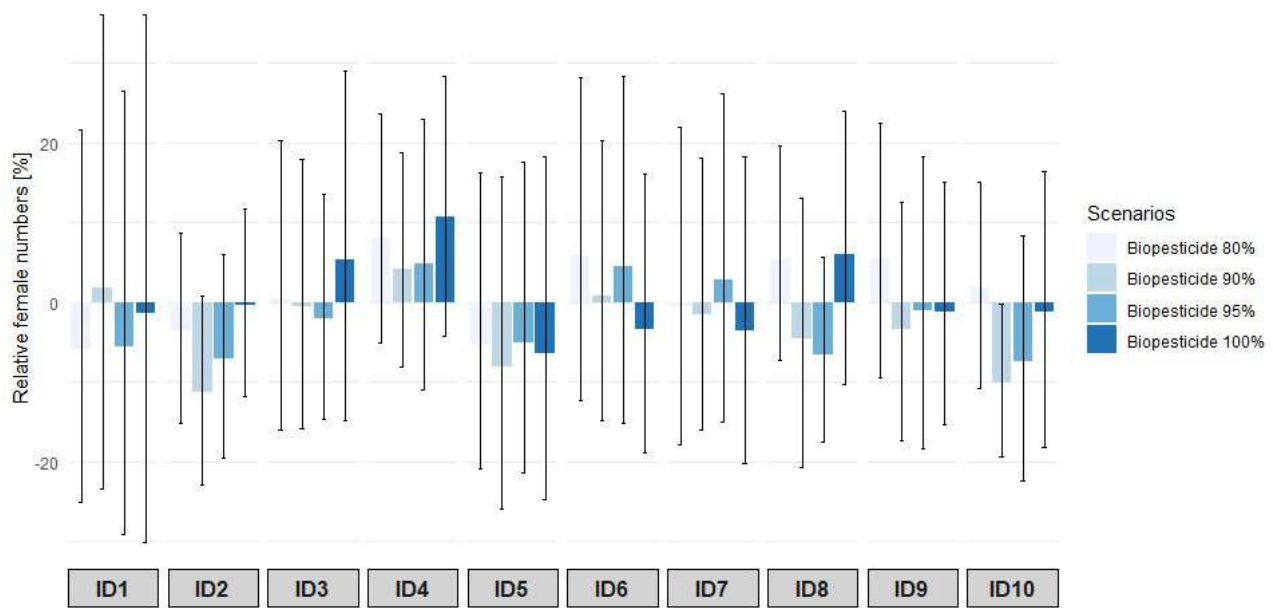


Figure 8.95 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in France.

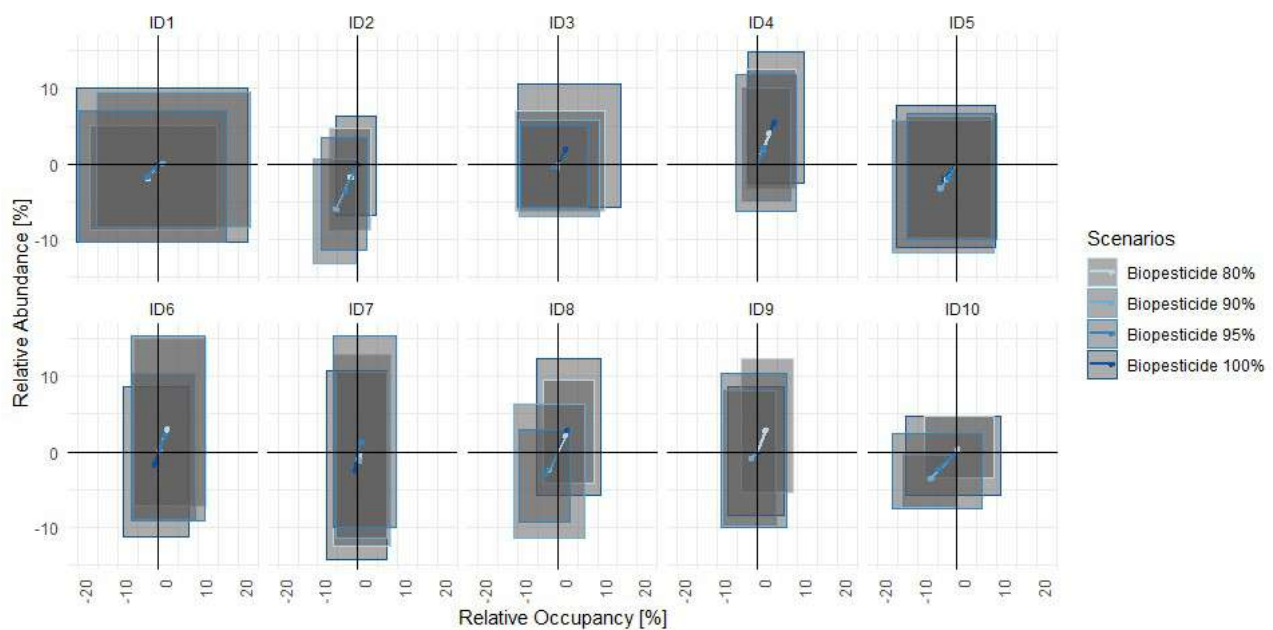


Figure 8.96 Biopesticide scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7 Netherlands

8.7.1 Flower field margins

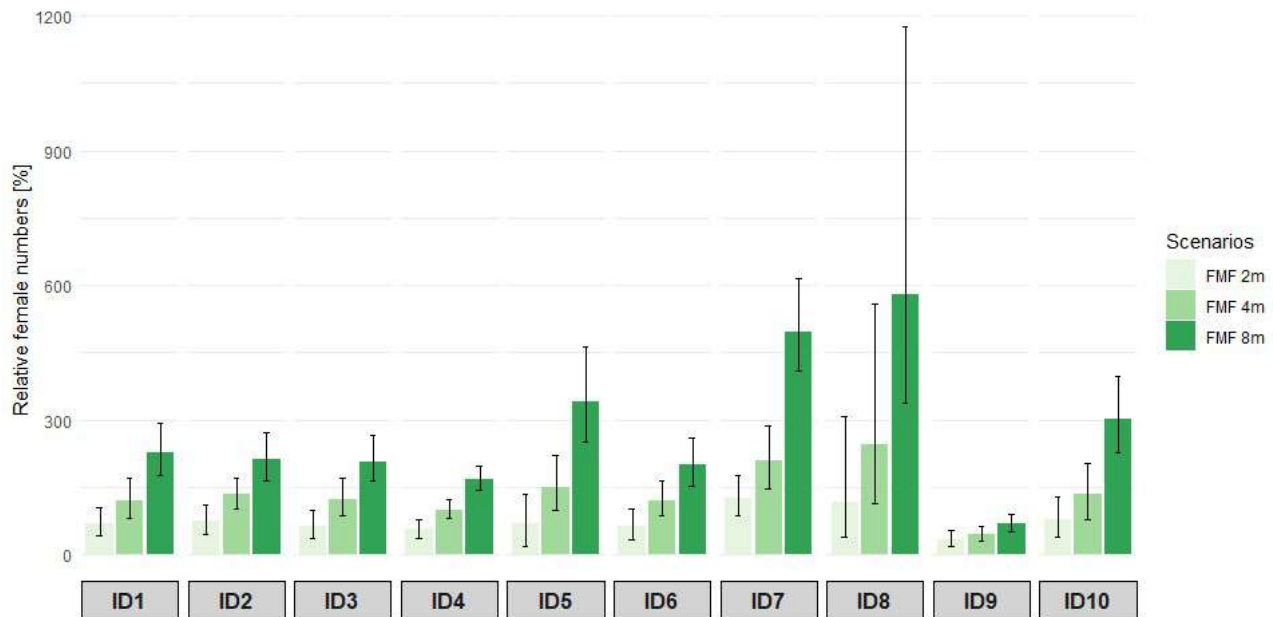


Figure 8.97 Flower field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

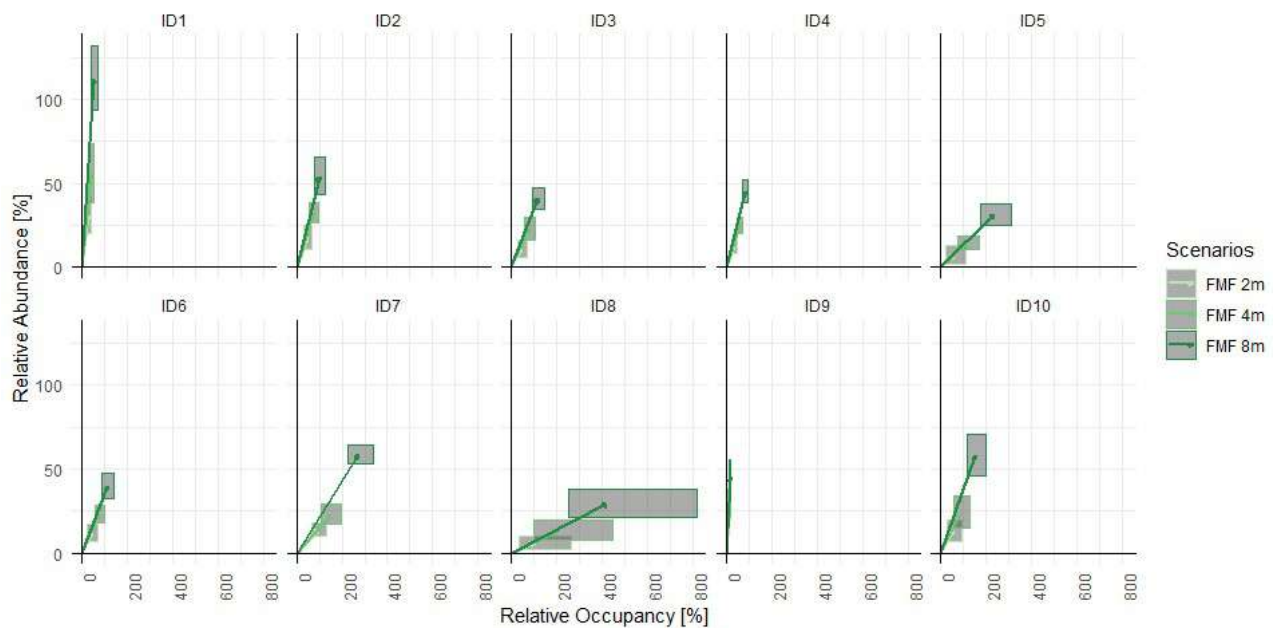


Figure 8.98 Flower field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7.2 Grassy field margins

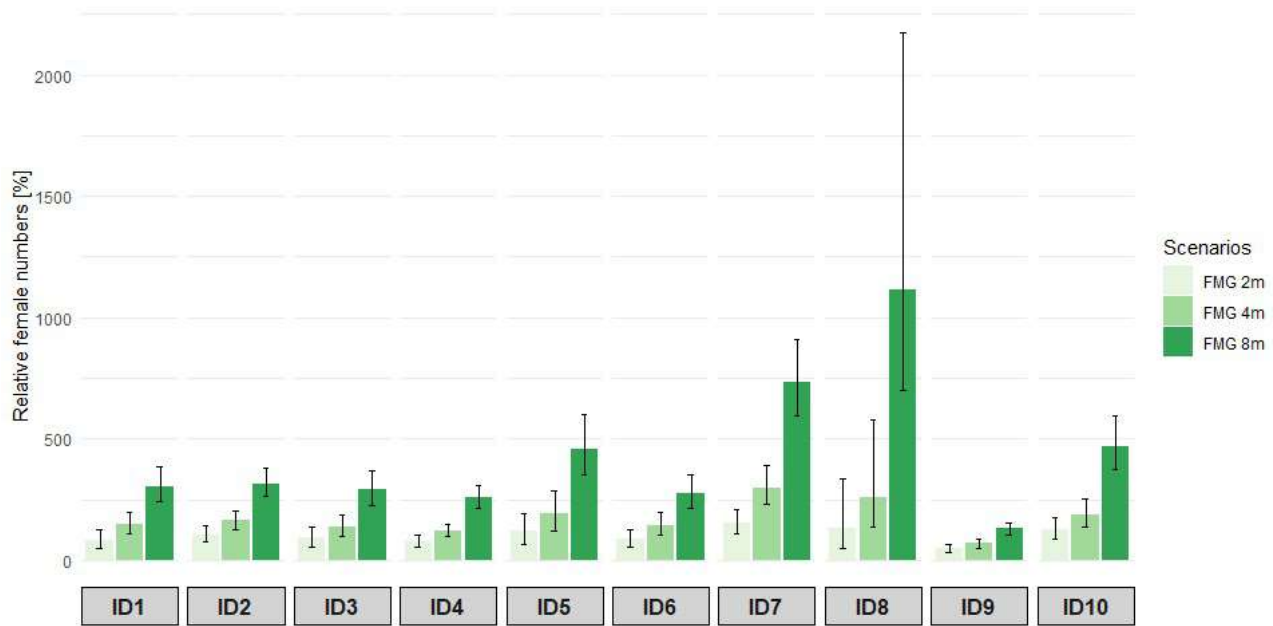


Figure 8.99 Grassy field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

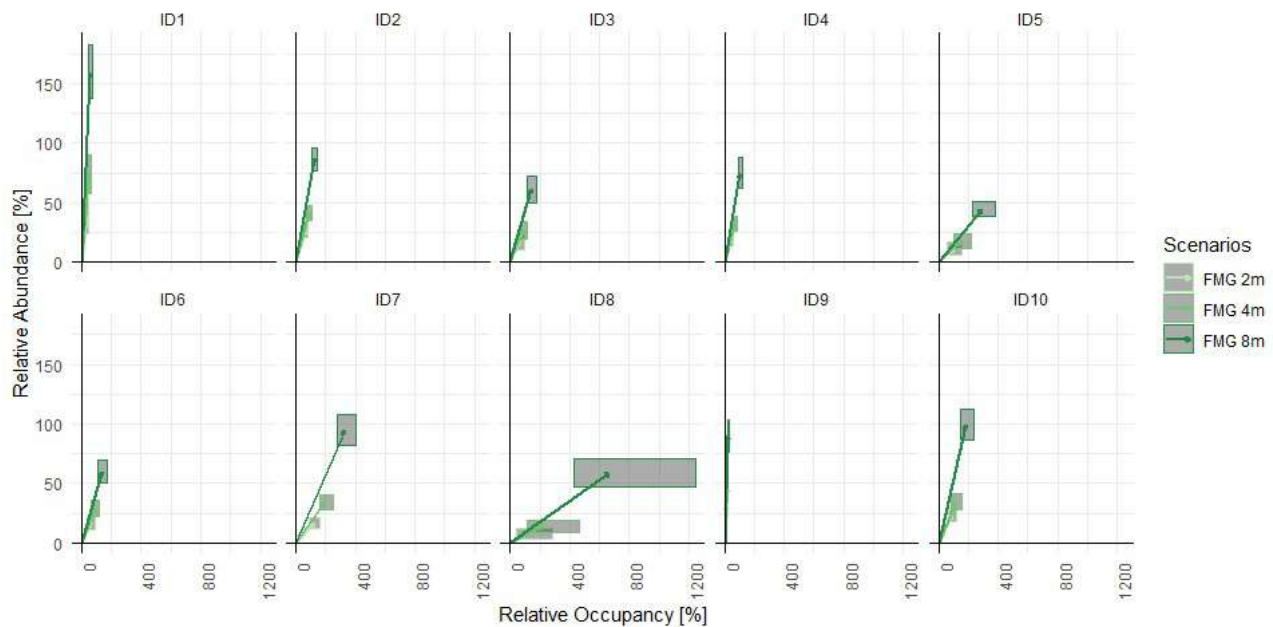


Figure 8.100 Grassy field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7.3 Mixed field margins

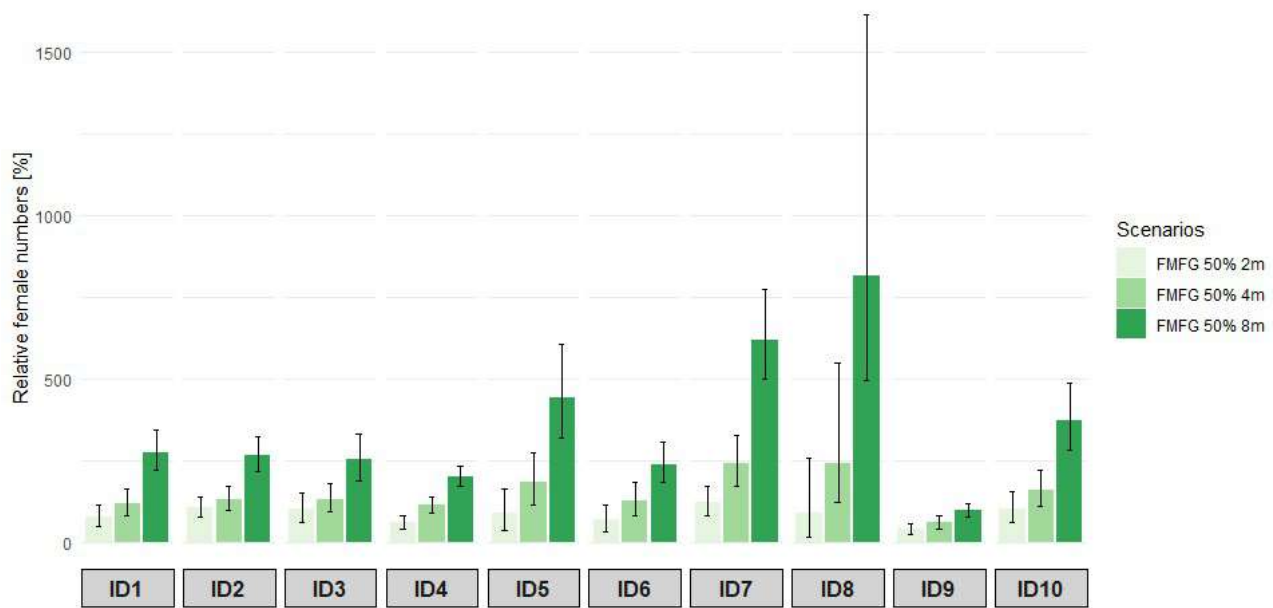


Figure 8.101 Mixed field margins scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

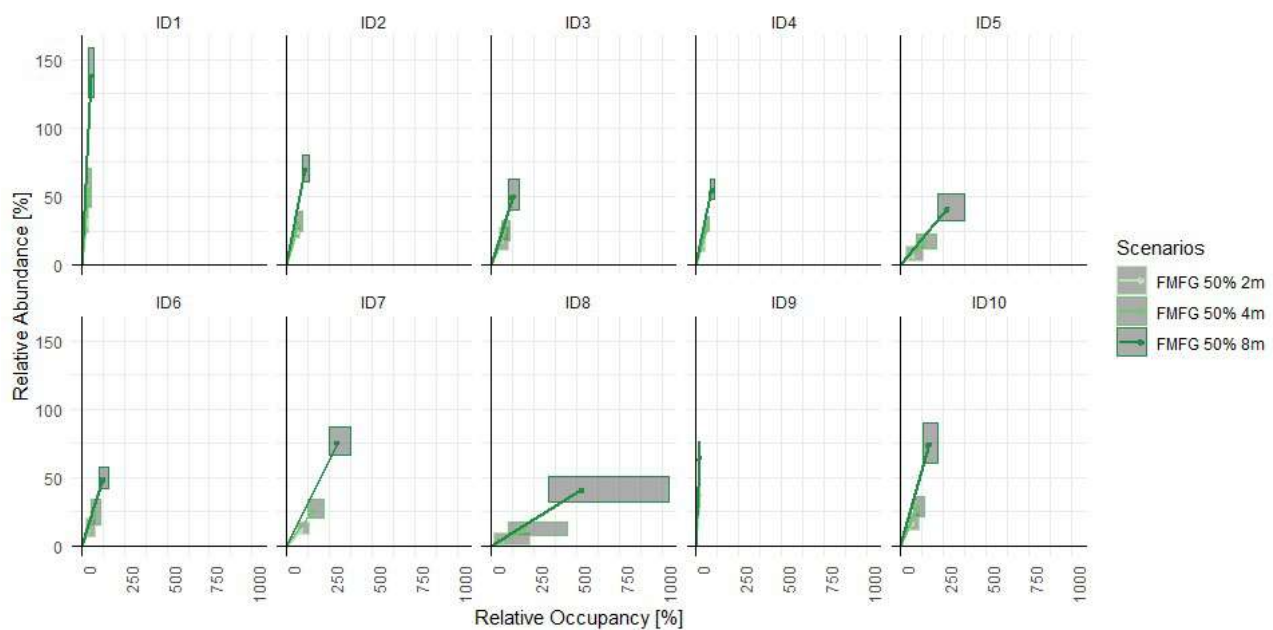


Figure 8.102 Mixed field margins with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7.4 Flower, grassy and mixed field margins

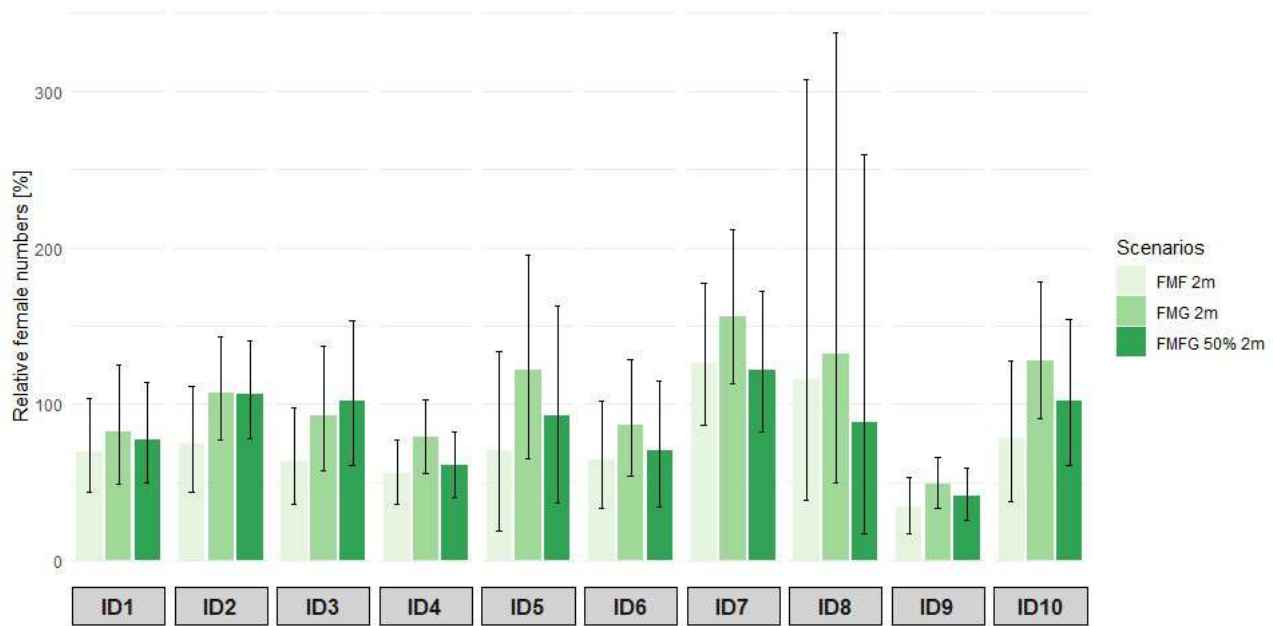


Figure 8.103 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

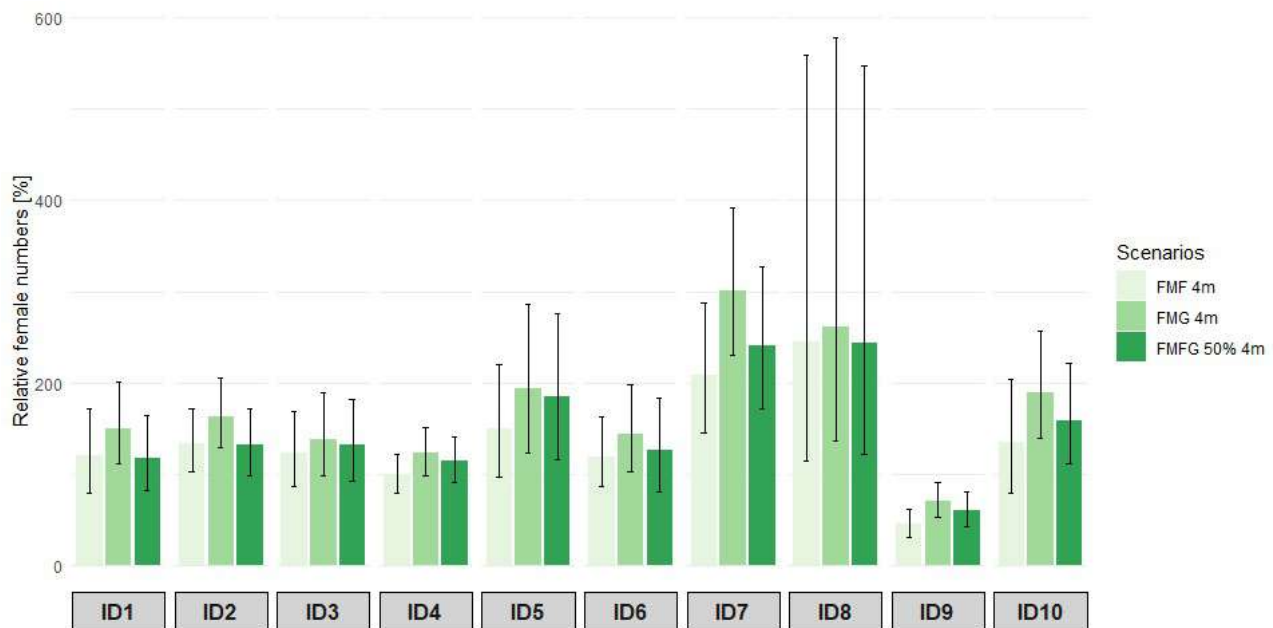


Figure 8.104 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

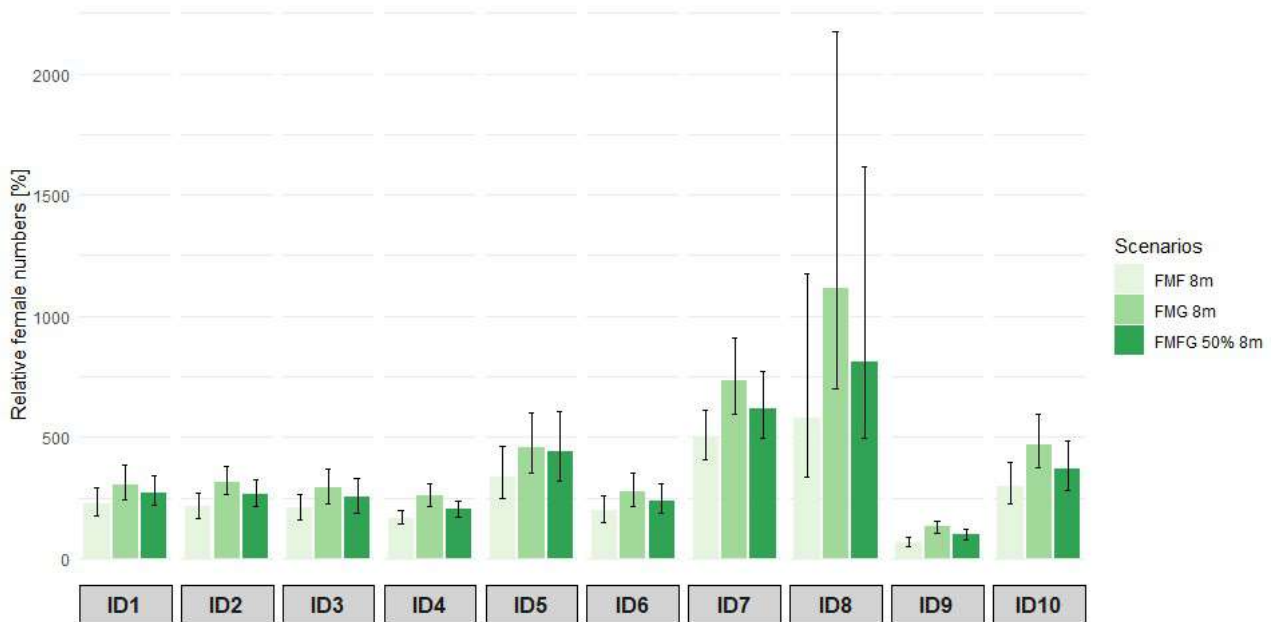


Figure 8.105 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

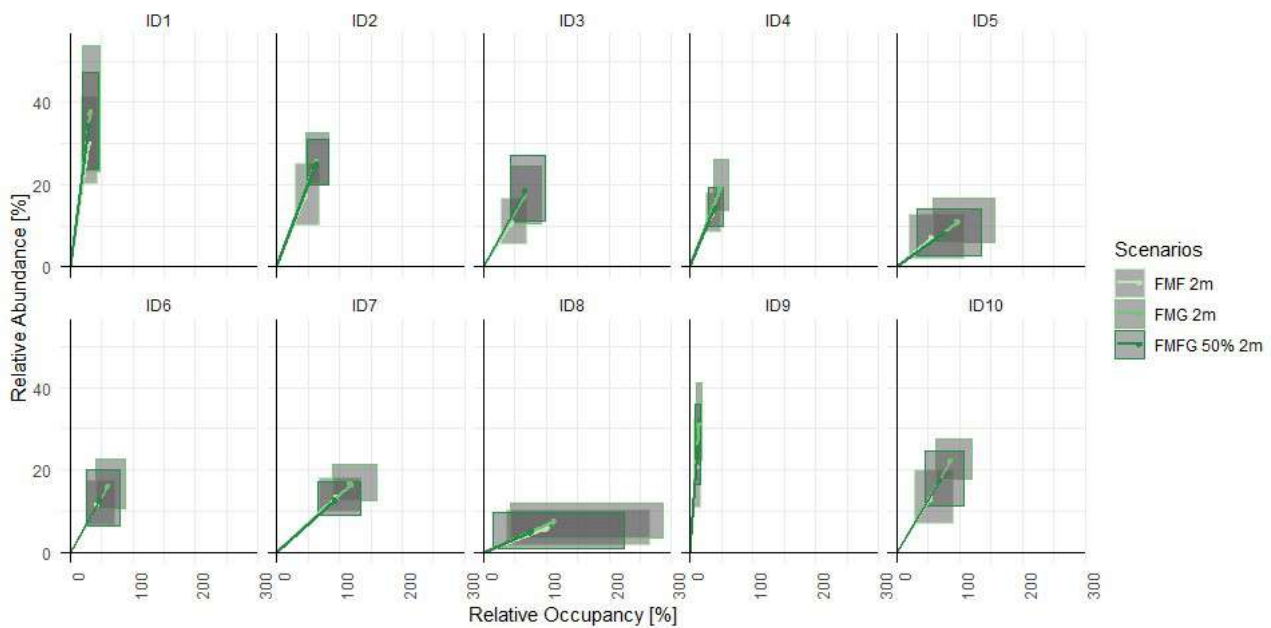


Figure 8.106 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

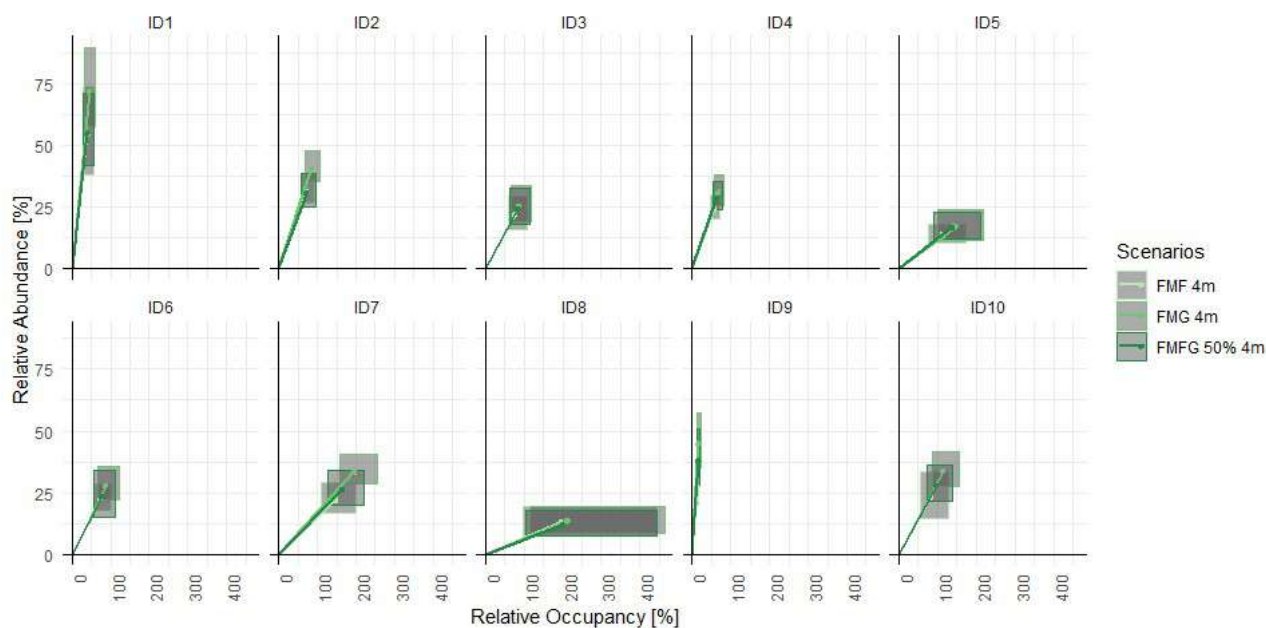


Figure 8.107 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes..

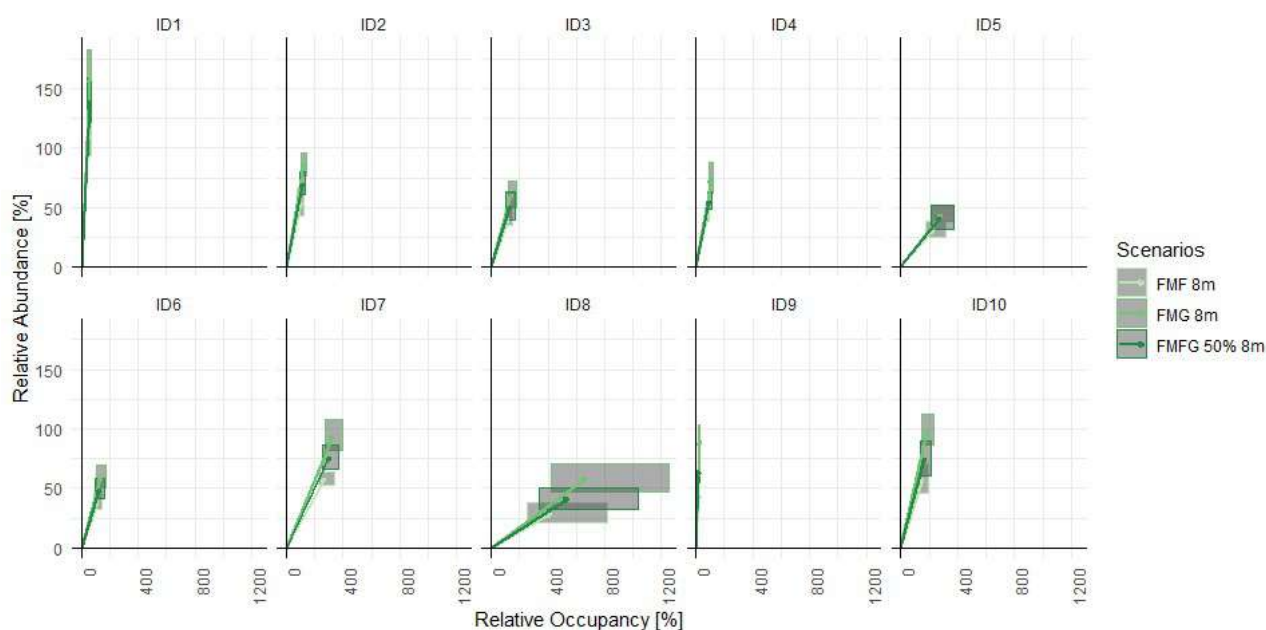


Figure 8.108 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7.5 Setaside

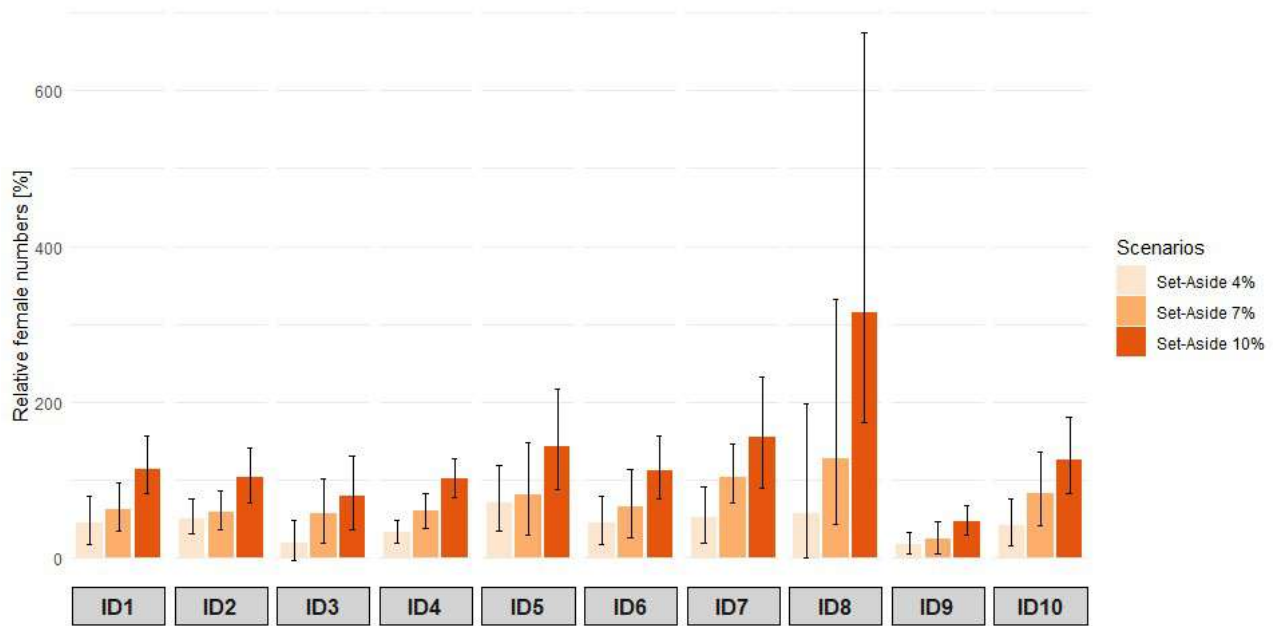


Figure 8.109 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

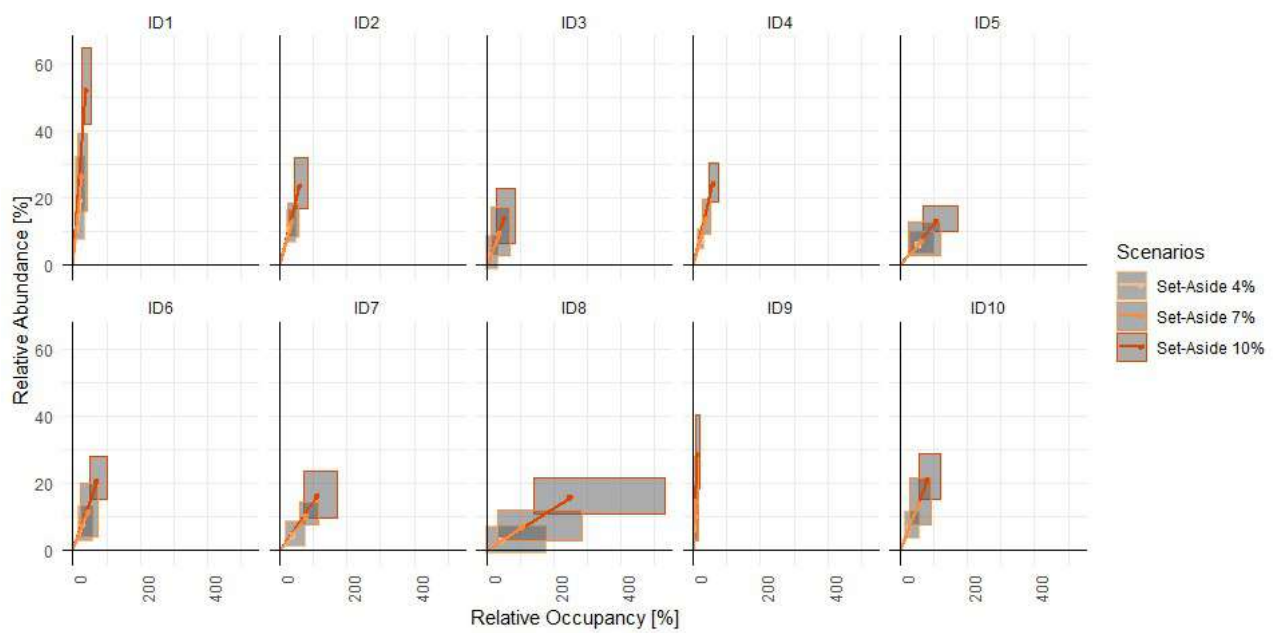


Figure 8.110 Setaside scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7.6 Legume

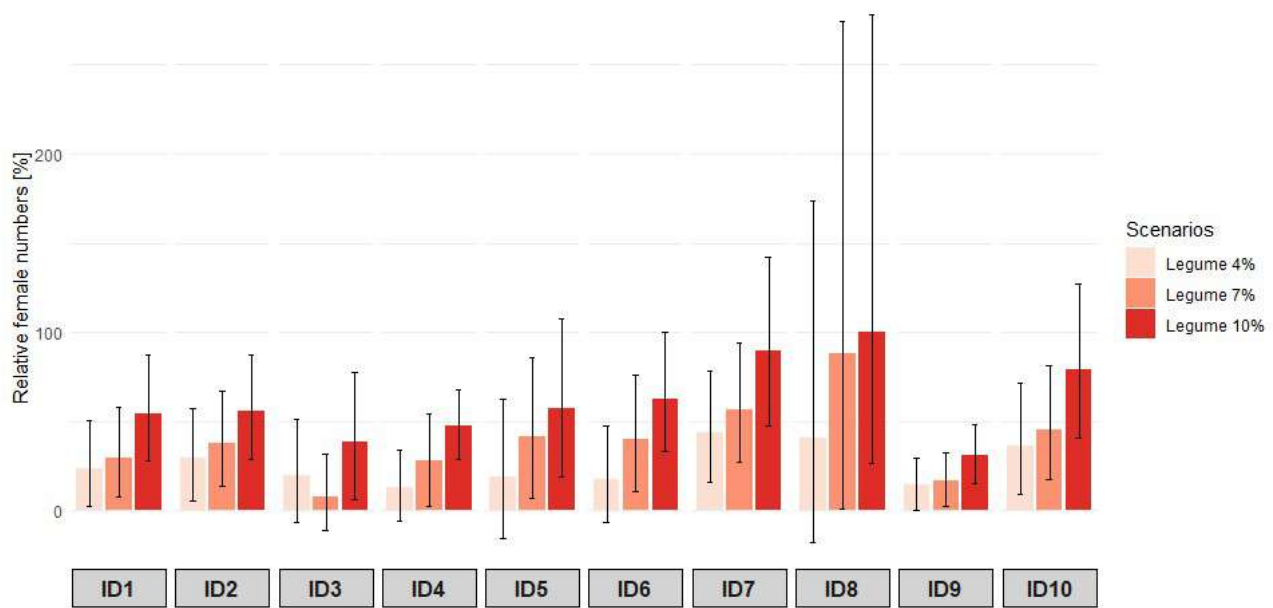


Figure 8.111 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

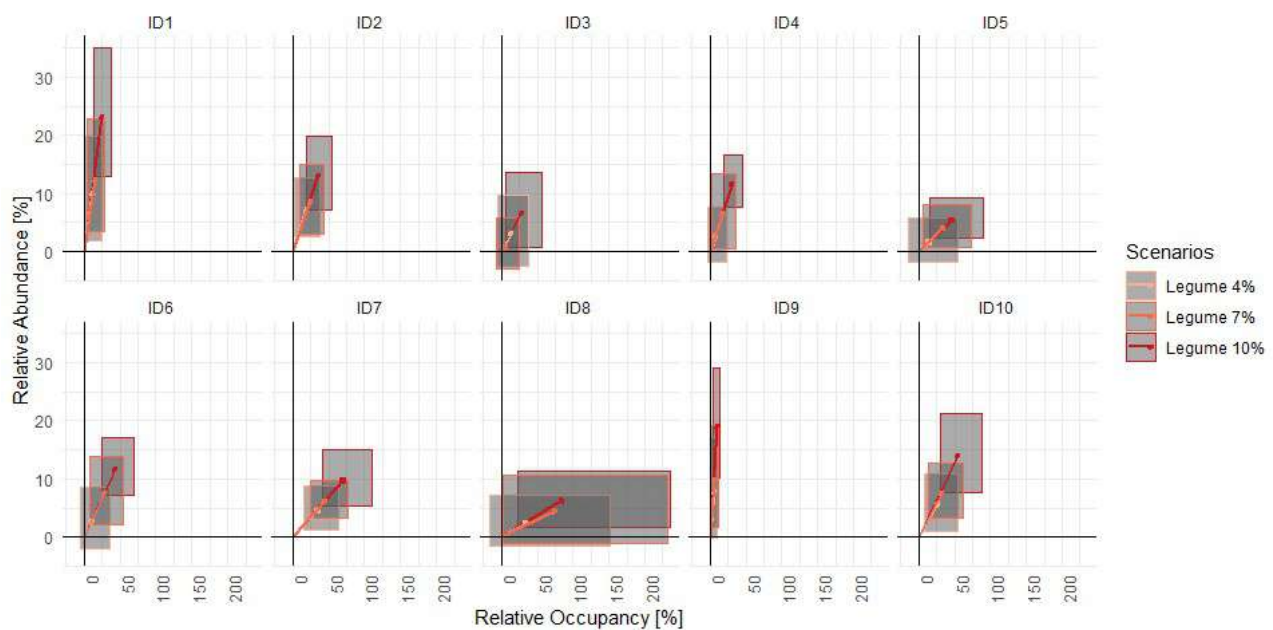


Figure 8.112 Legume scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.7.7 Biopesticides

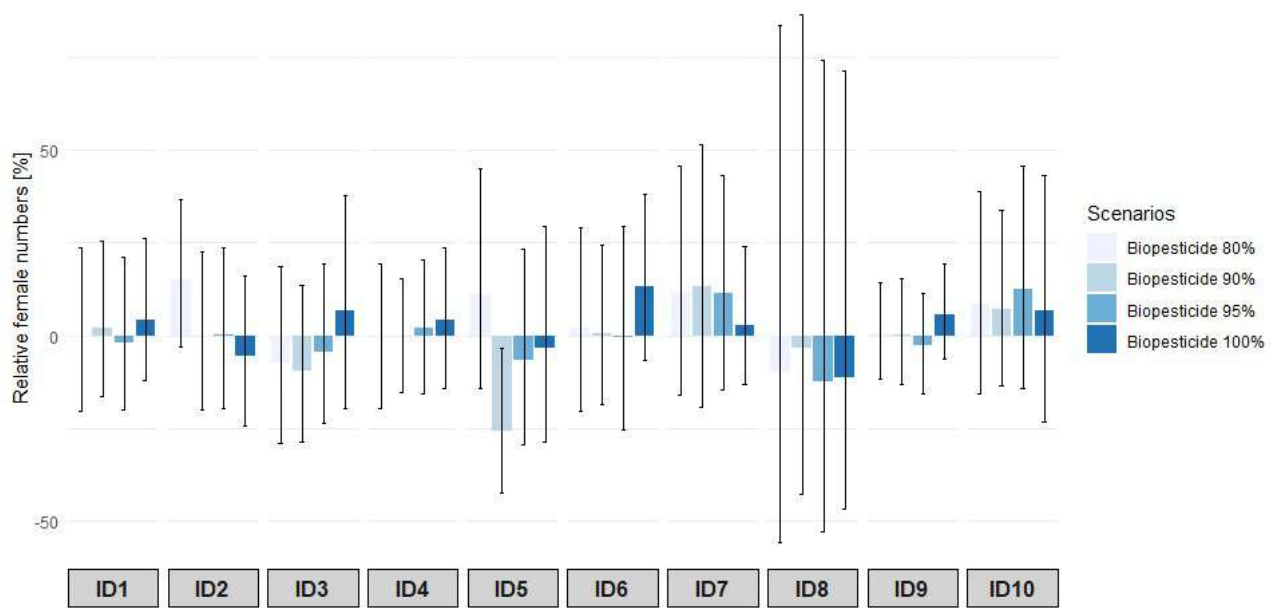


Figure 8.113 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

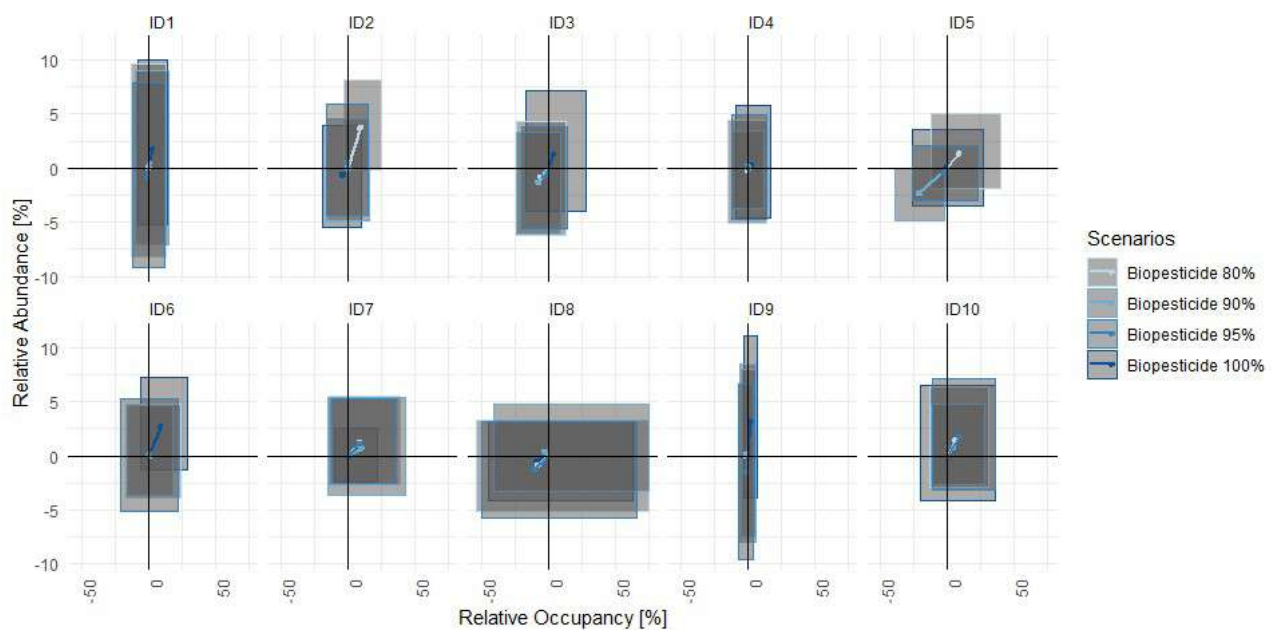


Figure 8.114 Biopesticide scenario with relative change in occupancy and abundance of female Hare compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

8.8 Combined landscapes

8.8.1 Crop diversification

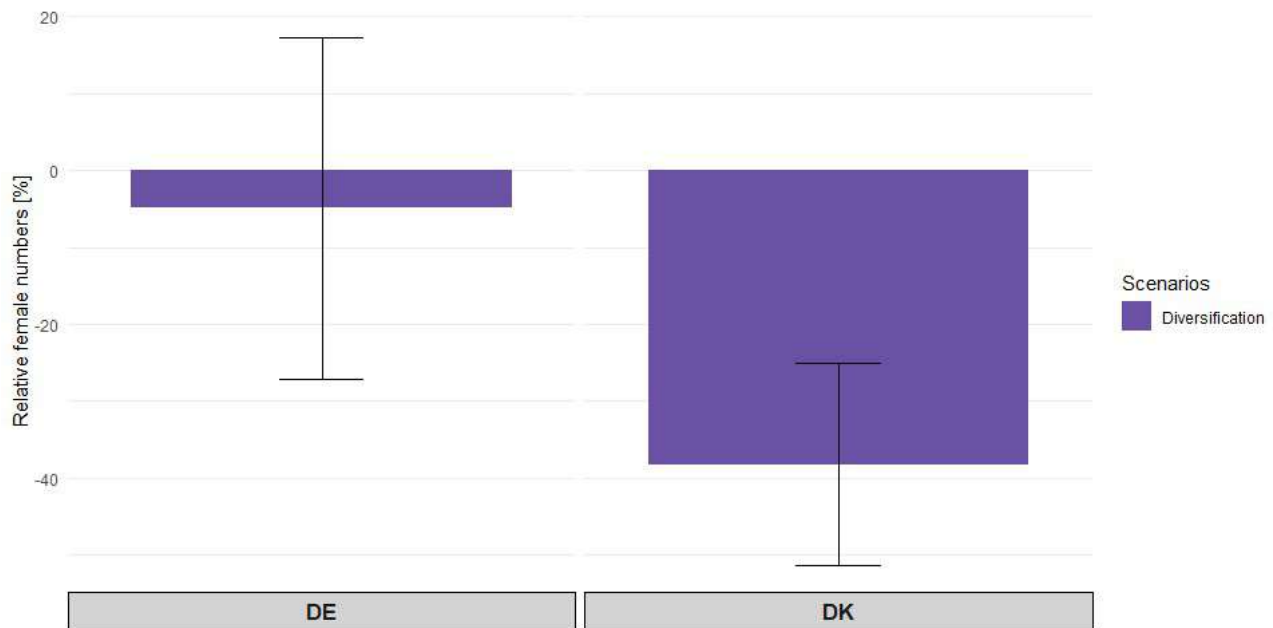


Figure 8.115 Diversification scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.2 Flower field margins

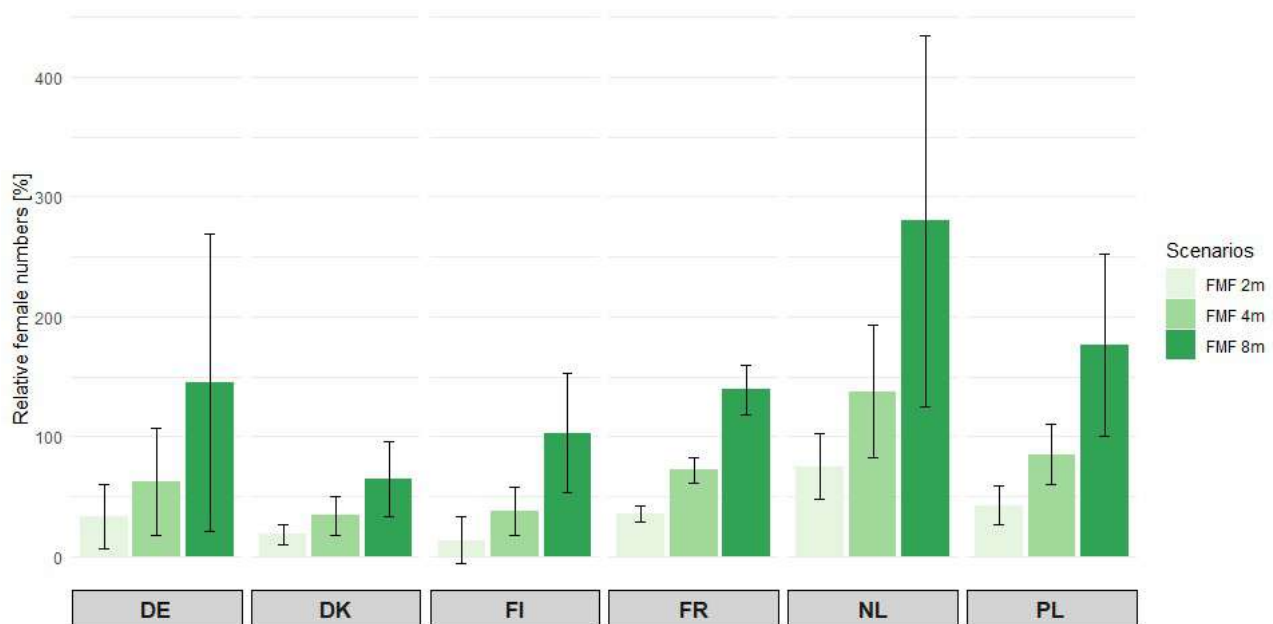


Figure 8.116 Flower field margins with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.3 Grassy field margins

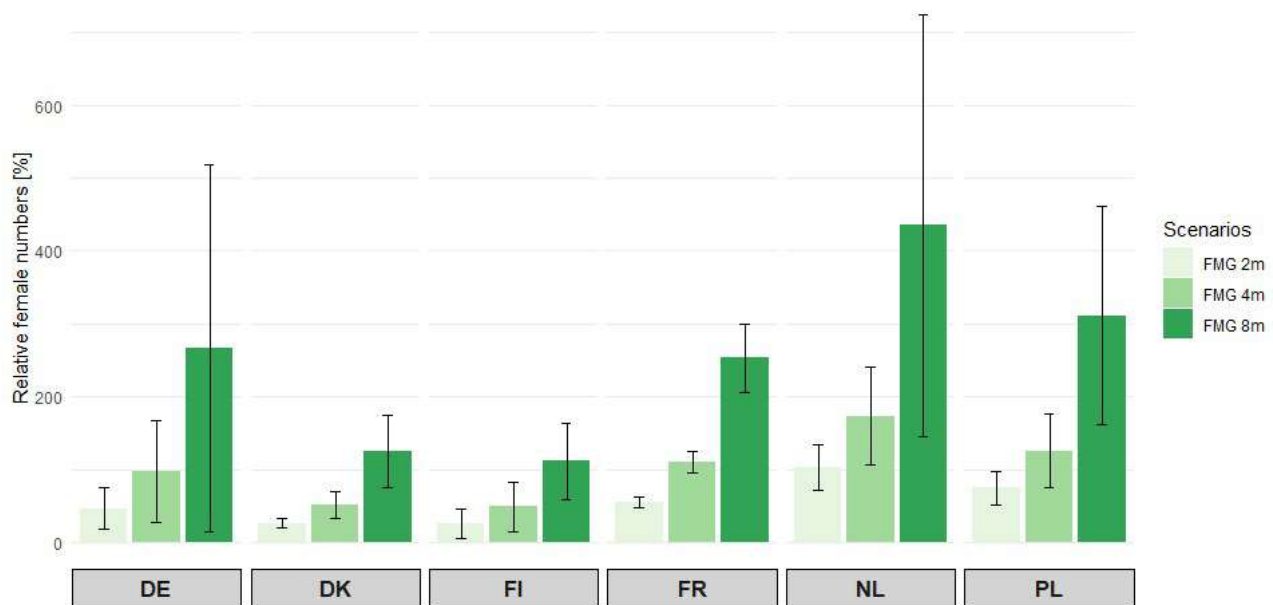


Figure 8.117 Grassy field margins with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.4 Mixed field margins

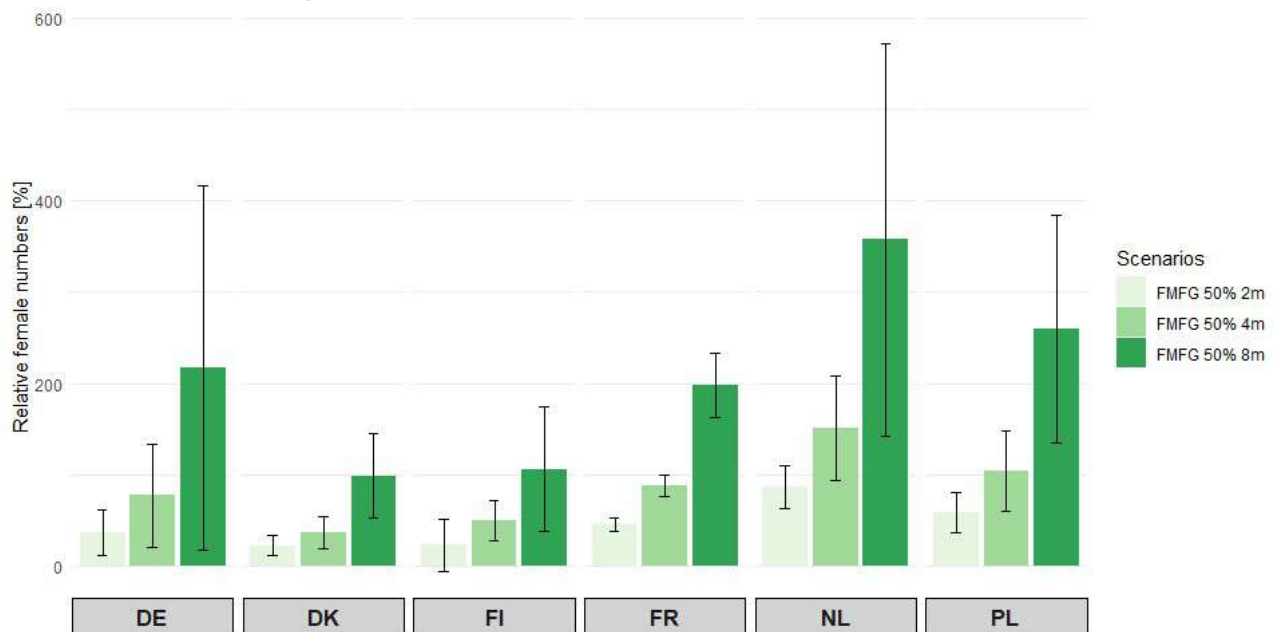


Figure 8.118 Mixed field margins with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.5 Flower, grassy and mixed margins

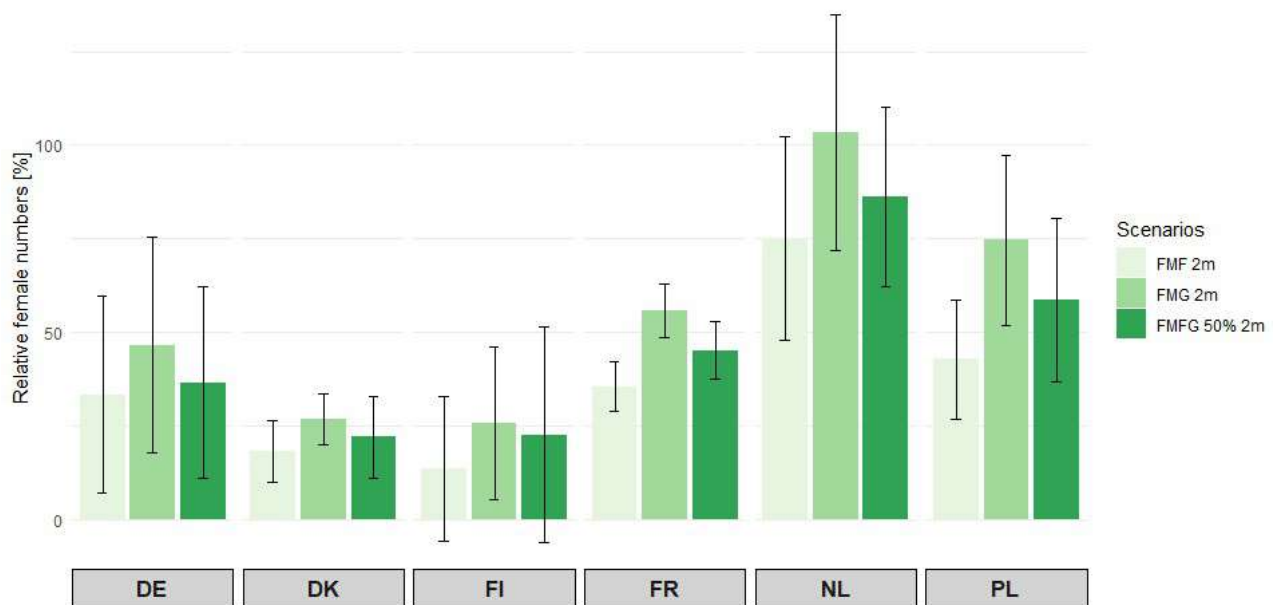


Figure 8.119 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

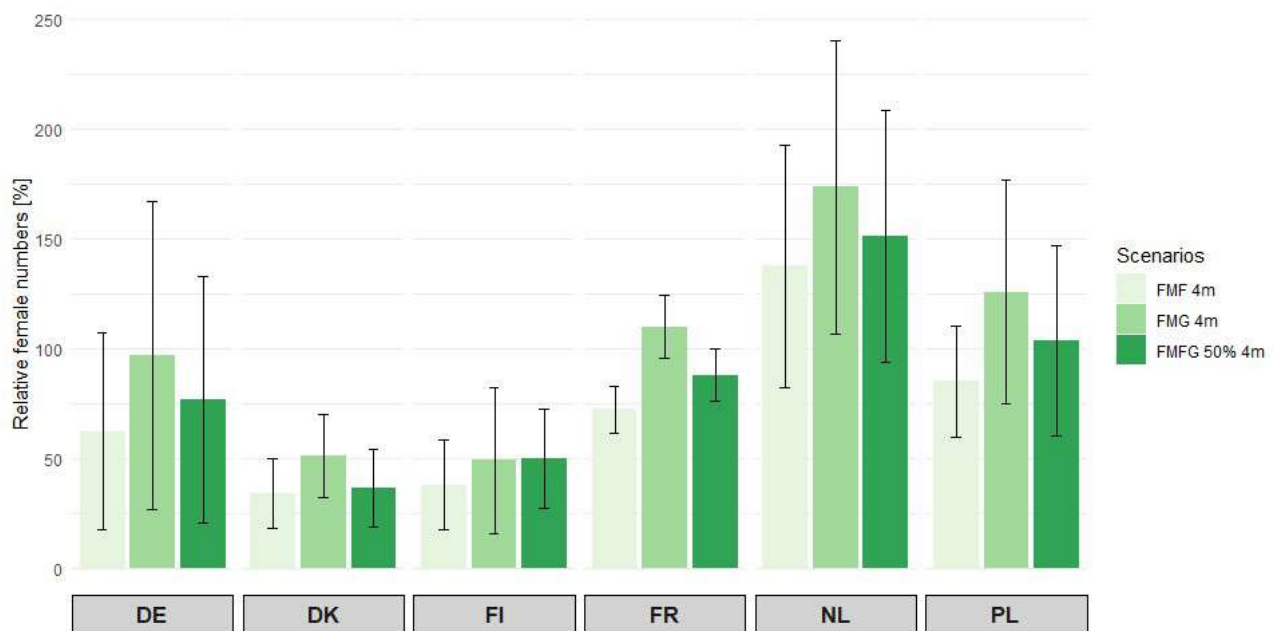


Figure 8.120 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

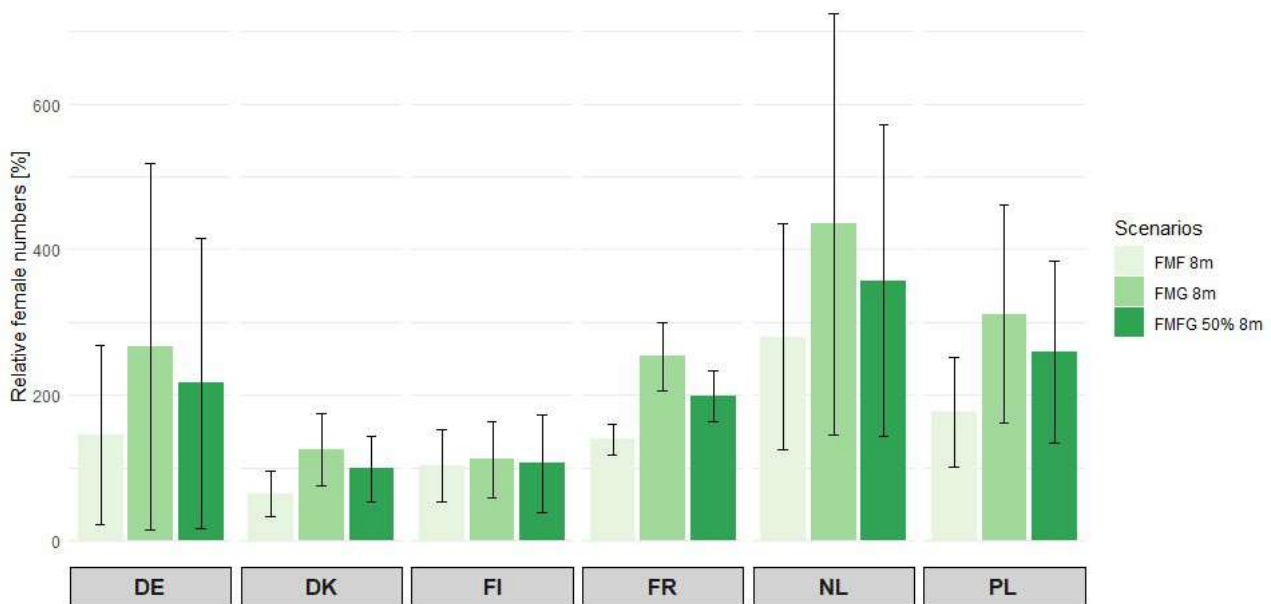


Figure 8.121 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.6 Setaside

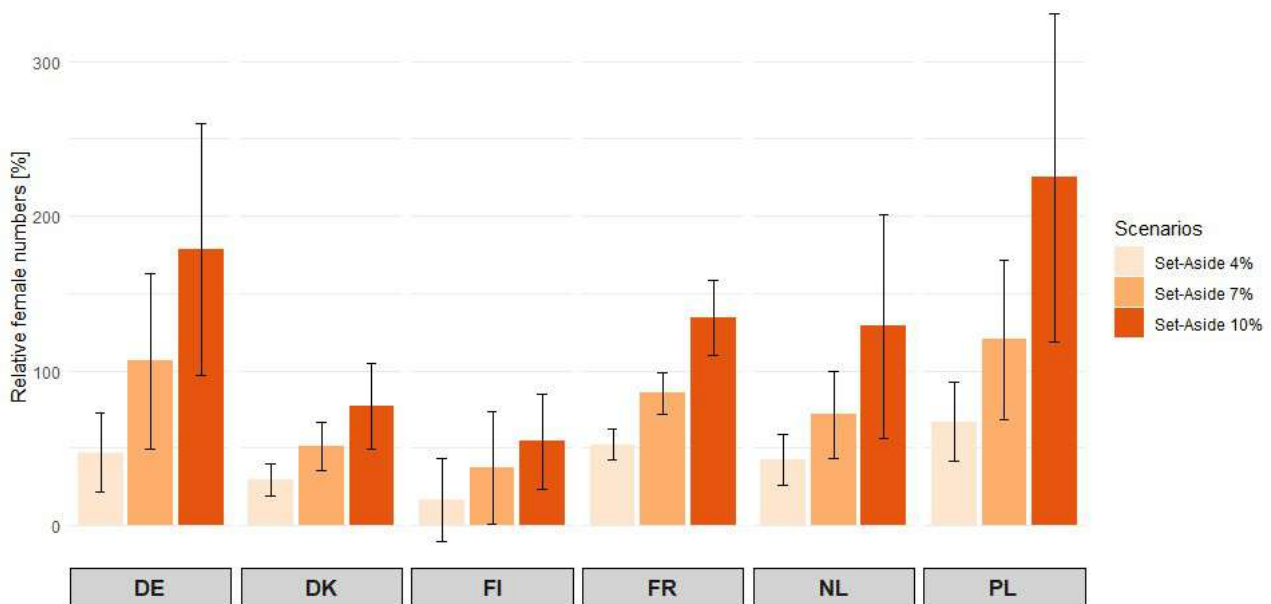


Figure 8.122 Setaside scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.7 Legume

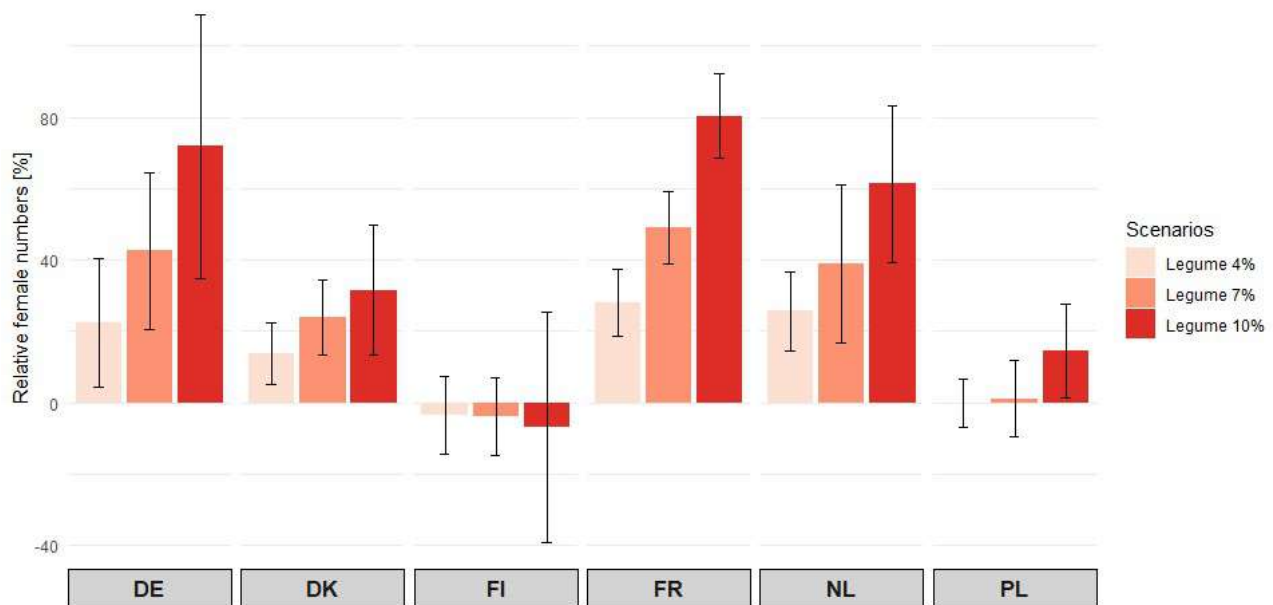


Figure 8.123 Legume scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.8 Biopesticides

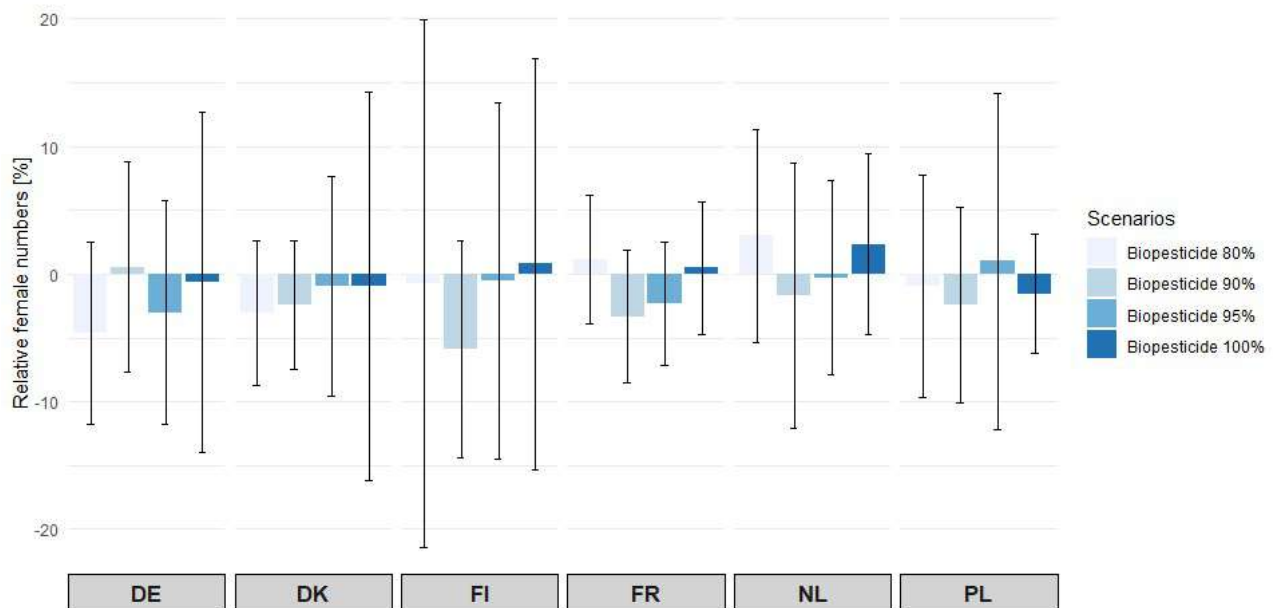


Figure 8.124 Biopesticide scenario with relative change in the number of female Hare compared to baseline and standard deviation presented by error bars for each simulated country.

8.8.9 Table: Country level overview of scenario effects

Table 8.1 Relative change and standard deviation of scenarios compared to the baseline for each country presented in percentages [%] for Hare. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	NL	PL	FR	FI
Diversification	-5% (SD 22%)	-38% (SD 13%)	NA	NA	NA	NA
FMF 2m	33% (SD 26%)	18% (SD 8%)	75% (SD 27%)	43% (SD 16%)	36% (SD 7%)	14% (SD 19%)
FMF 4m	62% (SD 45%)	34% (SD 16%)	138% (SD 55%)	85% (SD 25%)	72% (SD 11%)	38% (SD 20%)
FMF 8m	145% (SD 124%)	65% (SD 31%)	280% (SD 155%)	177% (SD 76%)	139% (SD 21%)	103% (SD 50%)
FMG 2m	47% (SD 29%)	27% (SD 7%)	103% (SD 32%)	75% (SD 23%)	56% (SD 7%)	26% (SD 20%)
FMG 4m	97% (SD 70%)	51% (SD 19%)	174% (SD 67%)	126% (SD 51%)	110% (SD 14%)	49% (SD 34%)
FMG 8m	267% (SD 251%)	125% (SD 49%)	435% (SD 289%)	312% (SD 150%)	253% (SD 47%)	112% (SD 53%)
FMFG 50% 2m	37% (SD 26%)	22% (SD 11%)	86% (SD 24%)	59% (SD 22%)	45% (SD 8%)	23% (SD 29%)
FMFG 50% 4m	77% (SD 56%)	37% (SD 18%)	151% (SD 57%)	104% (SD 43%)	88% (SD 12%)	50% (SD 22%)
FMFG 50% 8m	217% (SD 199%)	99% (SD 46%)	358% (SD 215%)	259% (SD 124%)	198% (SD 35%)	106% (SD 68%)
Set-Aside 4%	47% (SD 26%)	30% (SD 10%)	43% (SD 16%)	67% (SD 26%)	52% (SD 10%)	17% (SD 27%)
Set-Aside 7%	106% (SD 57%)	51% (SD 16%)	72% (SD 28%)	120% (SD 51%)	86% (SD 14%)	38% (SD 36%)
Set-Aside 10%	178% (SD 81%)	77% (SD 28%)	129% (SD 72%)	225% (SD 106%)	134% (SD 24%)	54% (SD 31%)
Legume 4%	22% (SD 18%)	14% (SD 9%)	26% (SD 11%)	-0% (SD 7%)	28% (SD 9%)	-4% (SD 11%)
Legume 7%	43% (SD 22%)	24% (SD 11%)	39% (SD 22%)	1% (SD 11%)	49% (SD 10%)	-4% (SD 11%)
Legume 10%	72% (SD 37%)	32% (SD 18%)	61% (SD 22%)	15% (SD 13%)	80% (SD 12%)	-7% (SD 32%)
Bio-pesticide 80%	-5% (SD 7%)	-3% (SD 6%)	3% (SD 8%)	-1% (SD 9%)	1% (SD 5%)	-1% (SD 21%)

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Scenario	DE	DK	NL	PL	FR	FI
Bio-pesticide 90%	1% (SD 8%)	-2% (SD 5%)	-2% (SD 10%)	-2% (SD 8%)	-3% (SD 5%)	-6% (SD 8%)
Bio-pesticide 95%	-3% (SD 9%)	-1% (SD 9%)	-0% (SD 8%)	1% (SD 13%)	-2% (SD 5%)	-1% (SD 14%)
Bio-pesticide 100%	-1% (SD 13%)	-1% (SD 15%)	2% (SD 7%)	-2% (SD 5%)	0% (SD 5%)	1% (SD 16%)

9 SKYLARK

9.1 Baselines

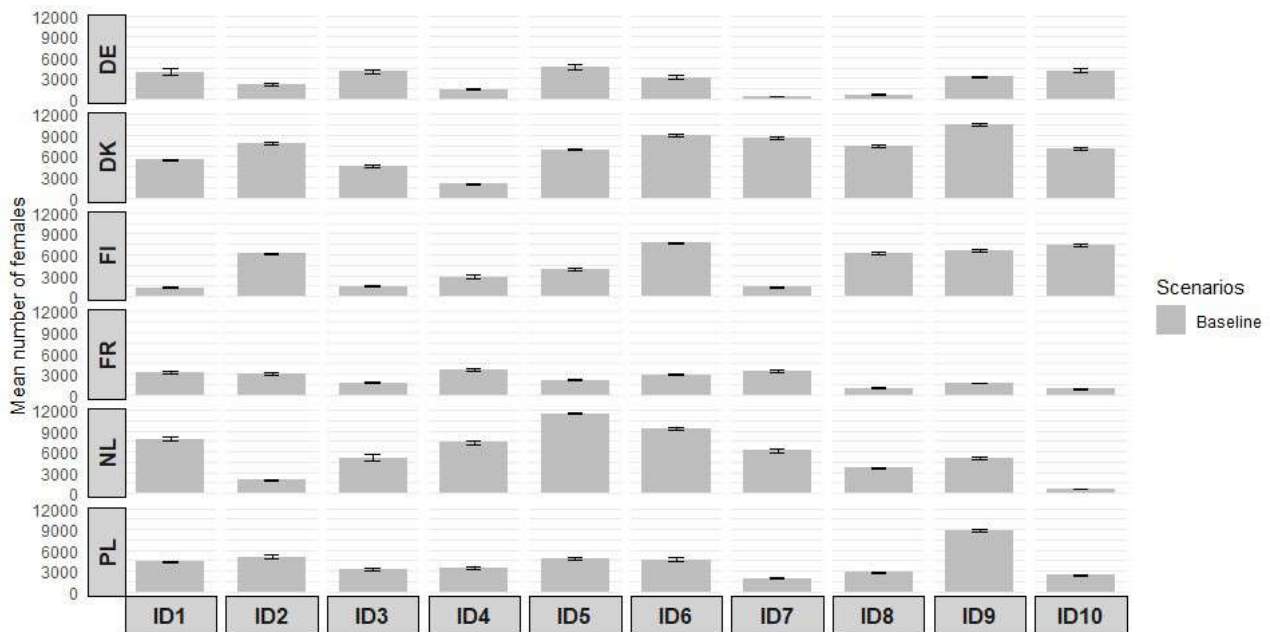


Figure 9.1 Skylark baselines for each country and landscape.

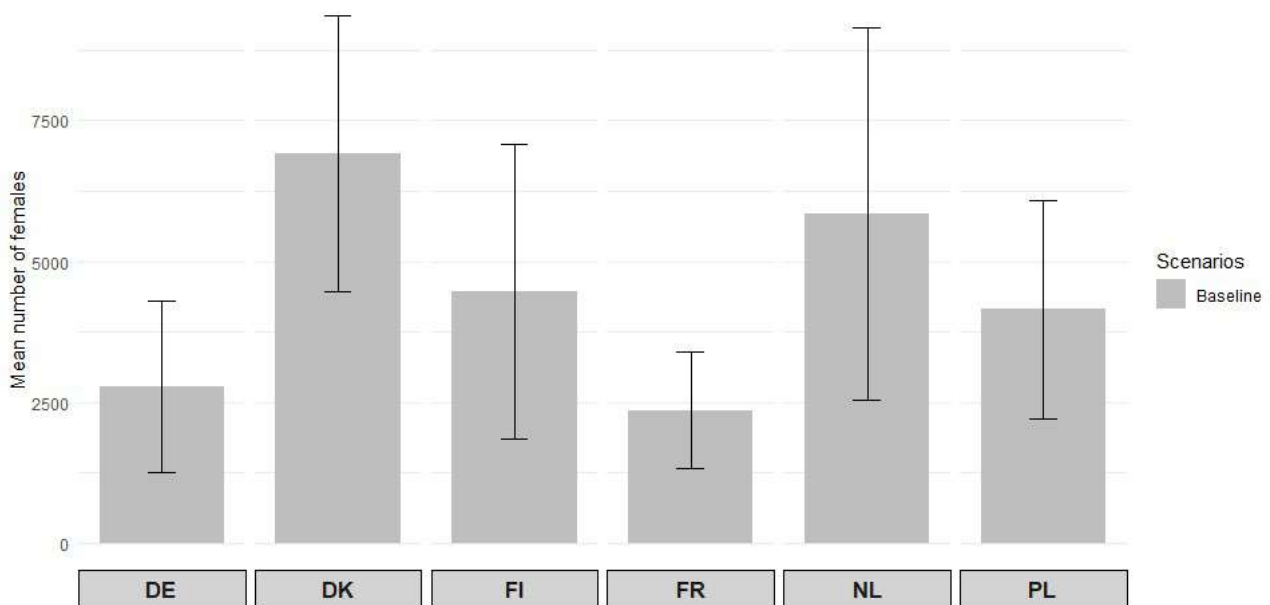


Figure 9.2 Skylark baselines for each country combined across landscapes.

9.2 Germany

9.2.1 Crop diversification



Figure 9.3 Diversification scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

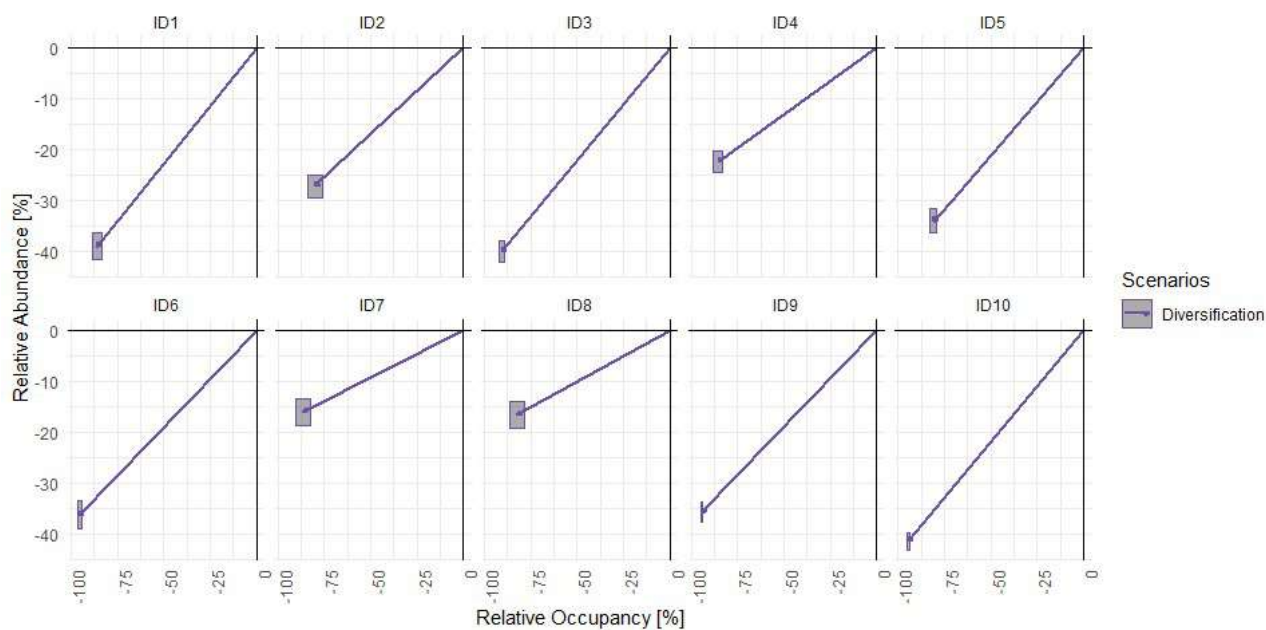


Figure 9.4 Diversification scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.2 Flower field margins

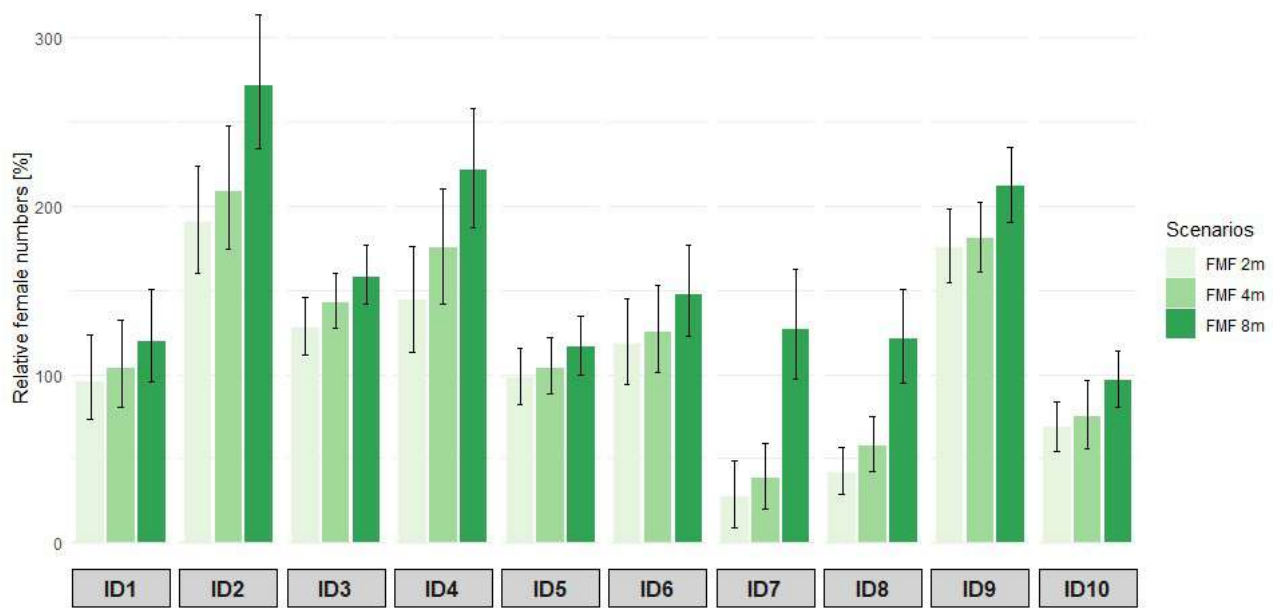


Figure 9.5 Flower field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

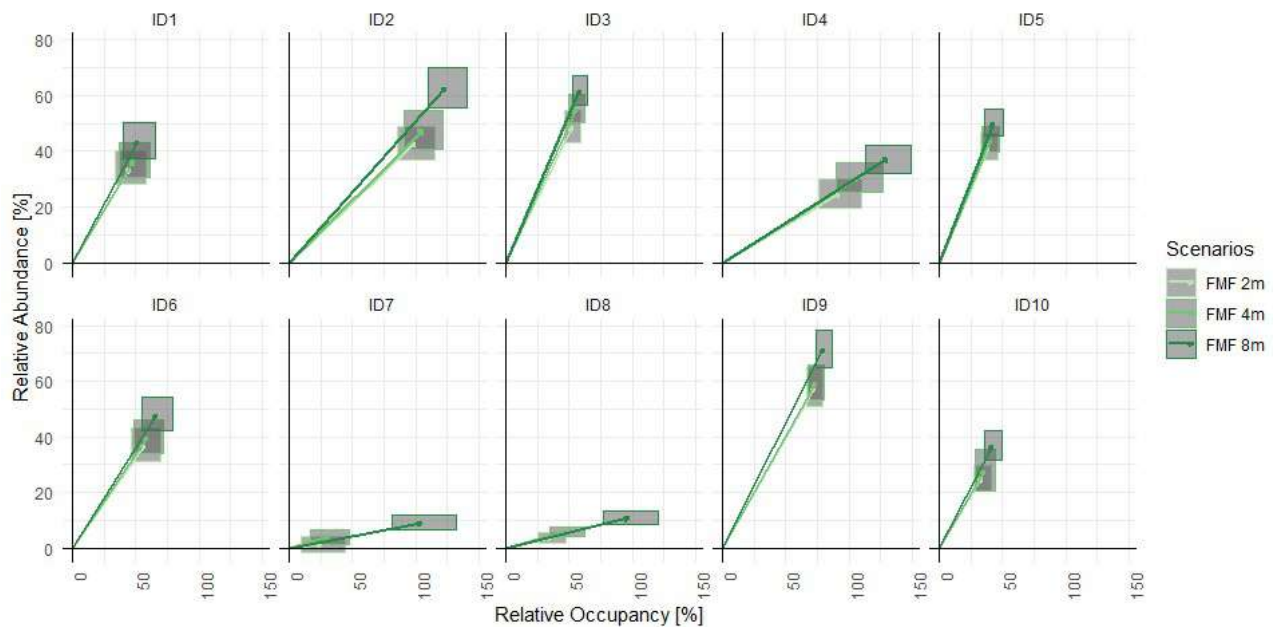


Figure 9.6 Flower field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.3 Grassy field margins

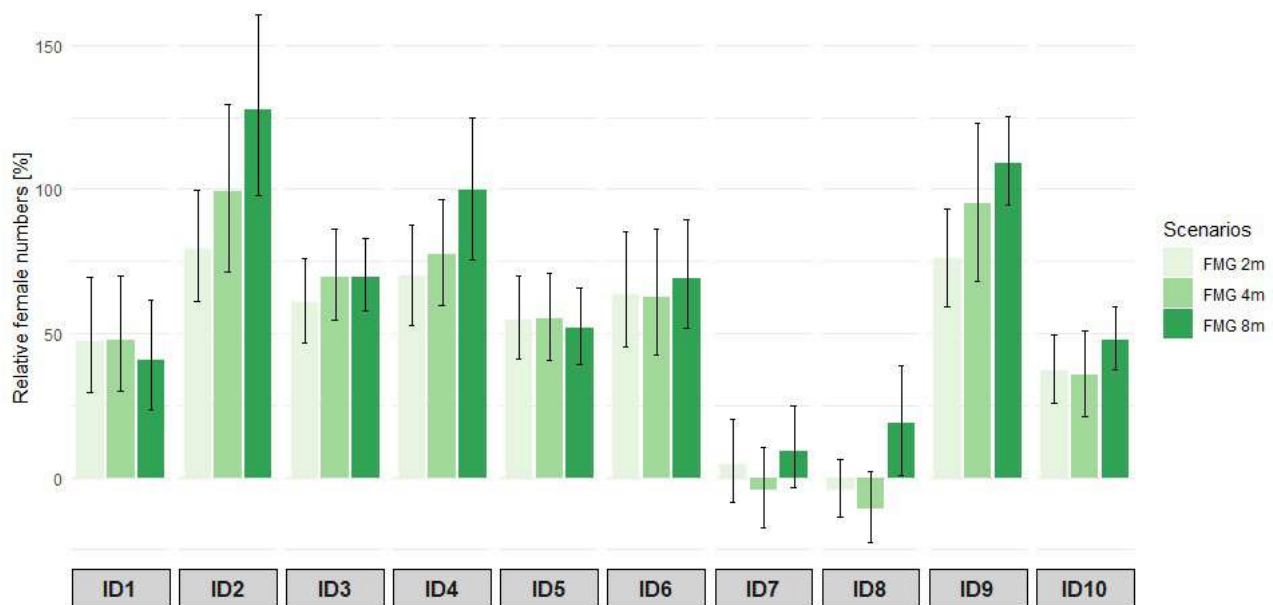


Figure 9.7 Grassy field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

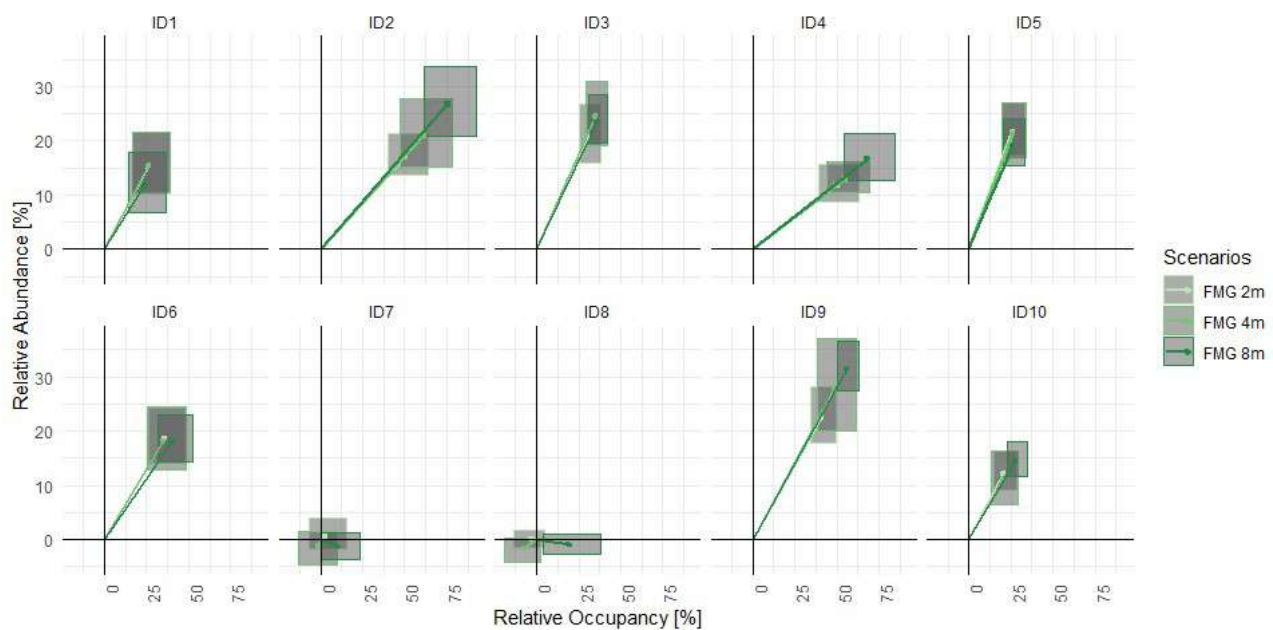


Figure 9.8 Grassy field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.4 Mixed field margins

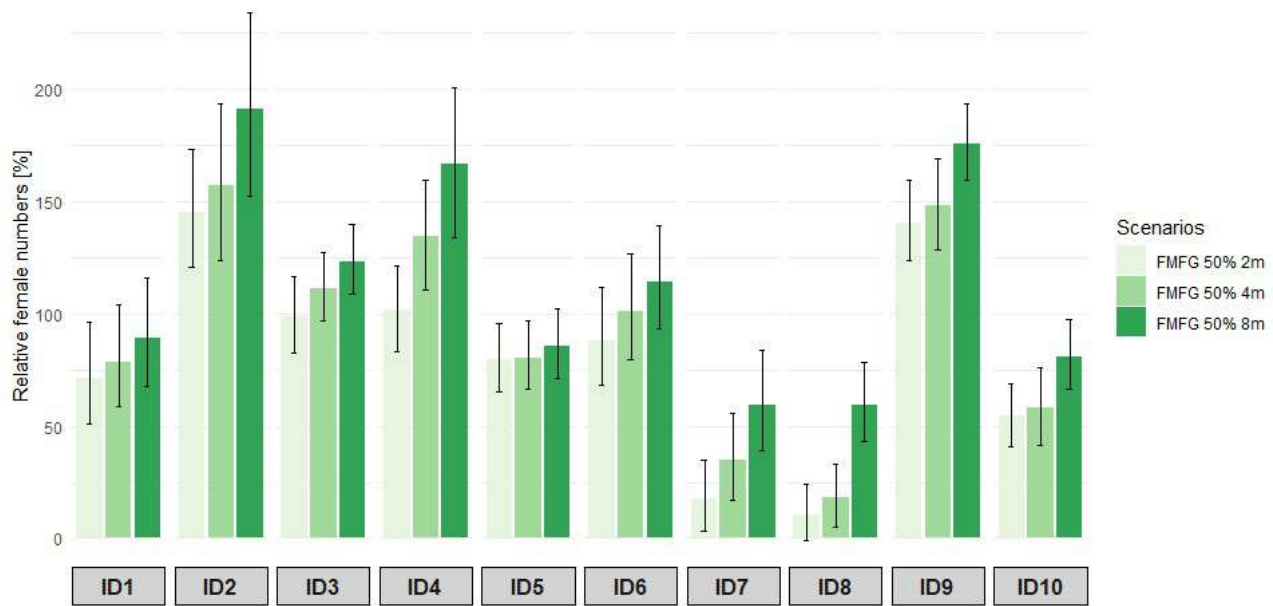


Figure 9.9 Mixed field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

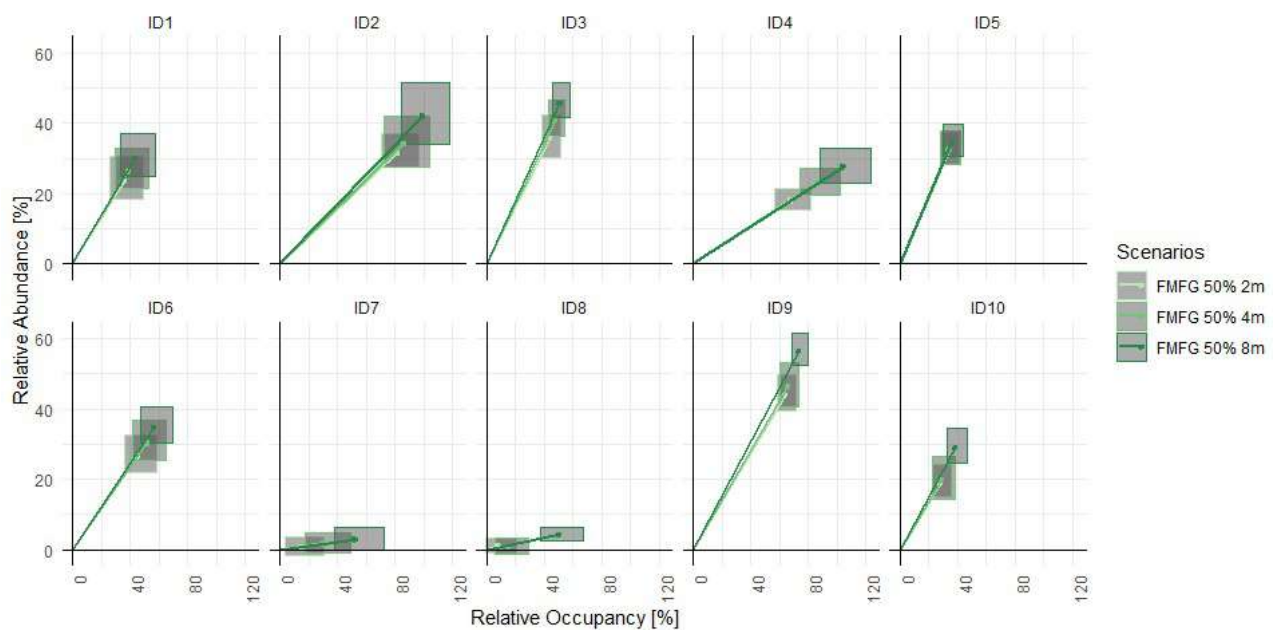


Figure 9.10 Mixed field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.5 Flower, grassy and mixed field margins

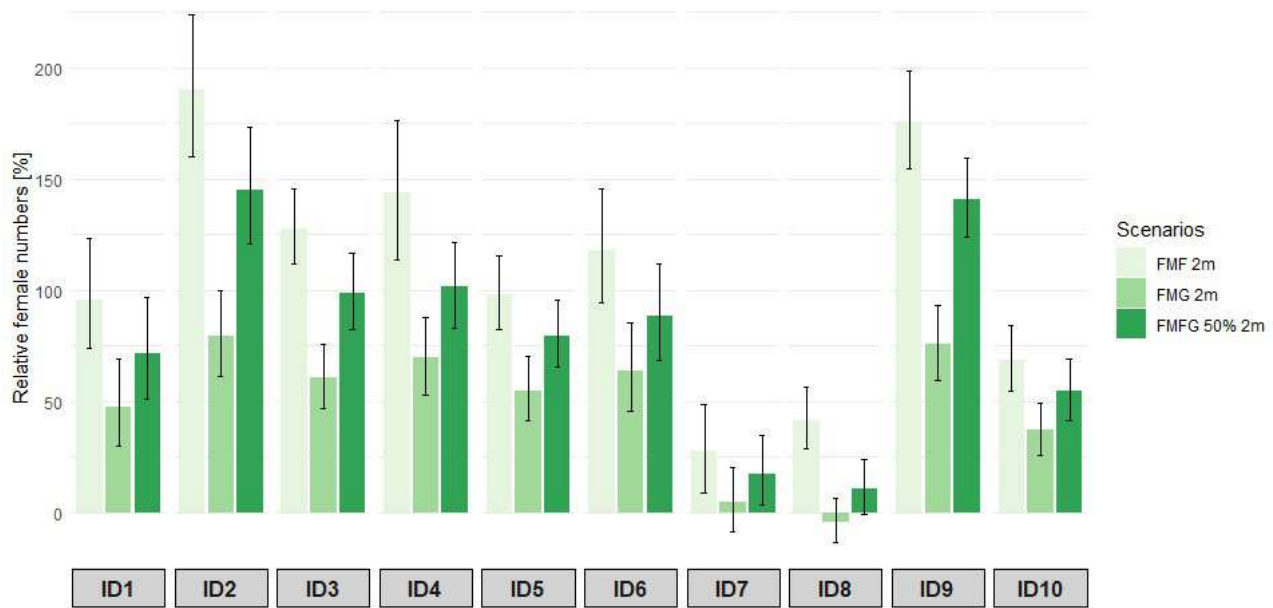


Figure 9.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

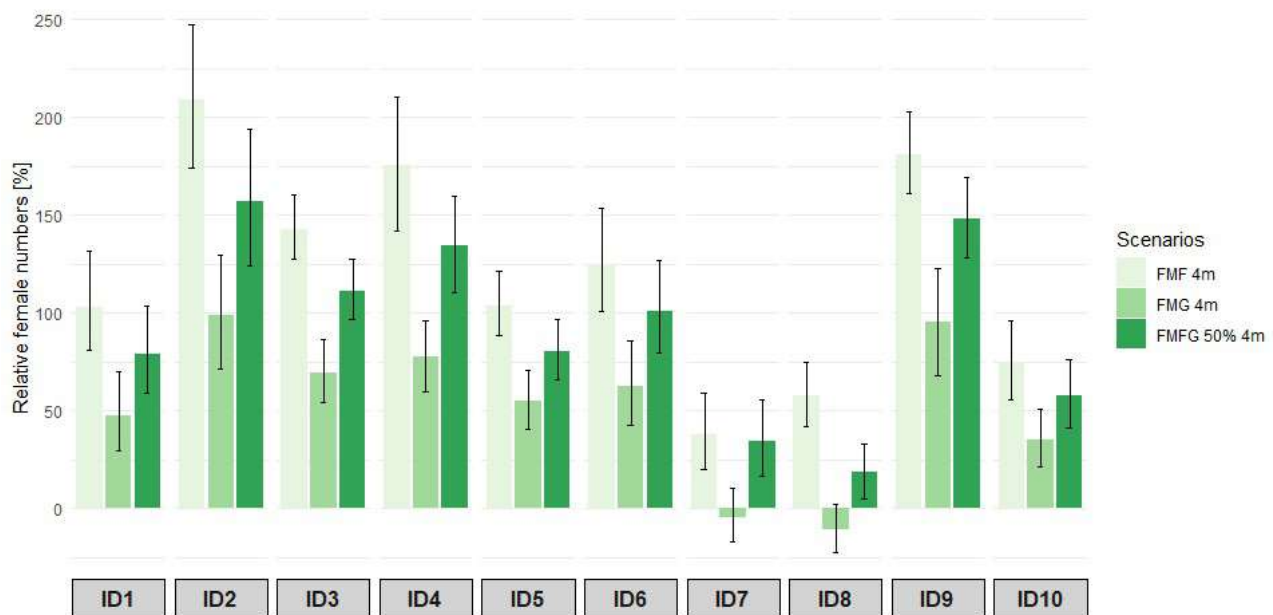


Figure 9.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

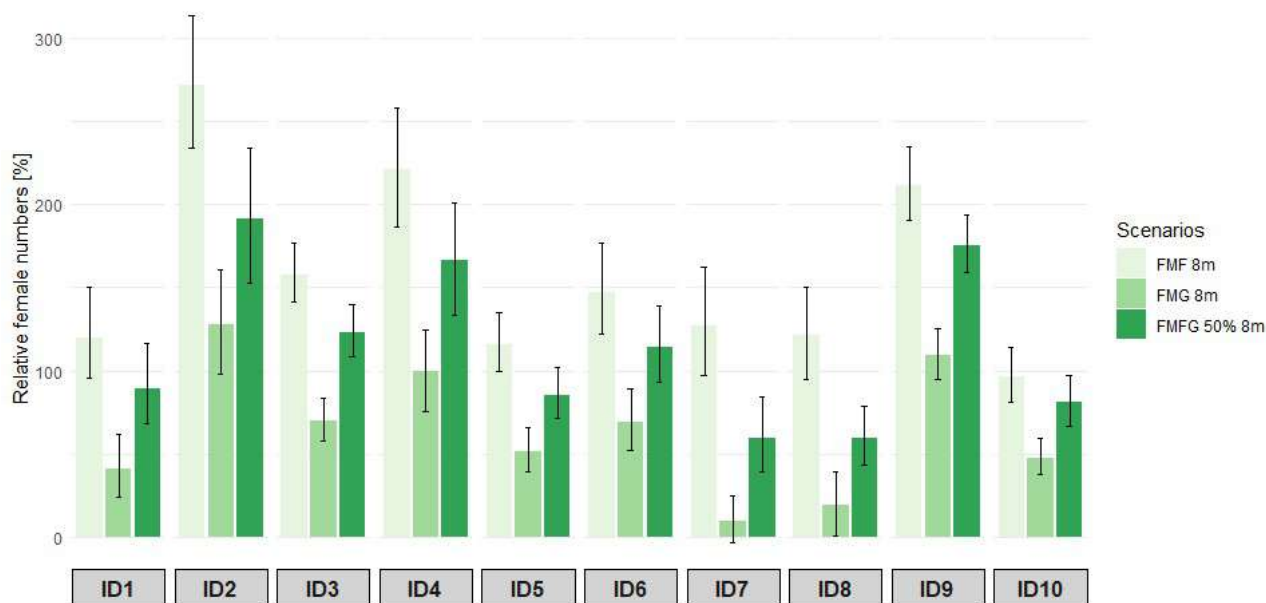


Figure 9.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

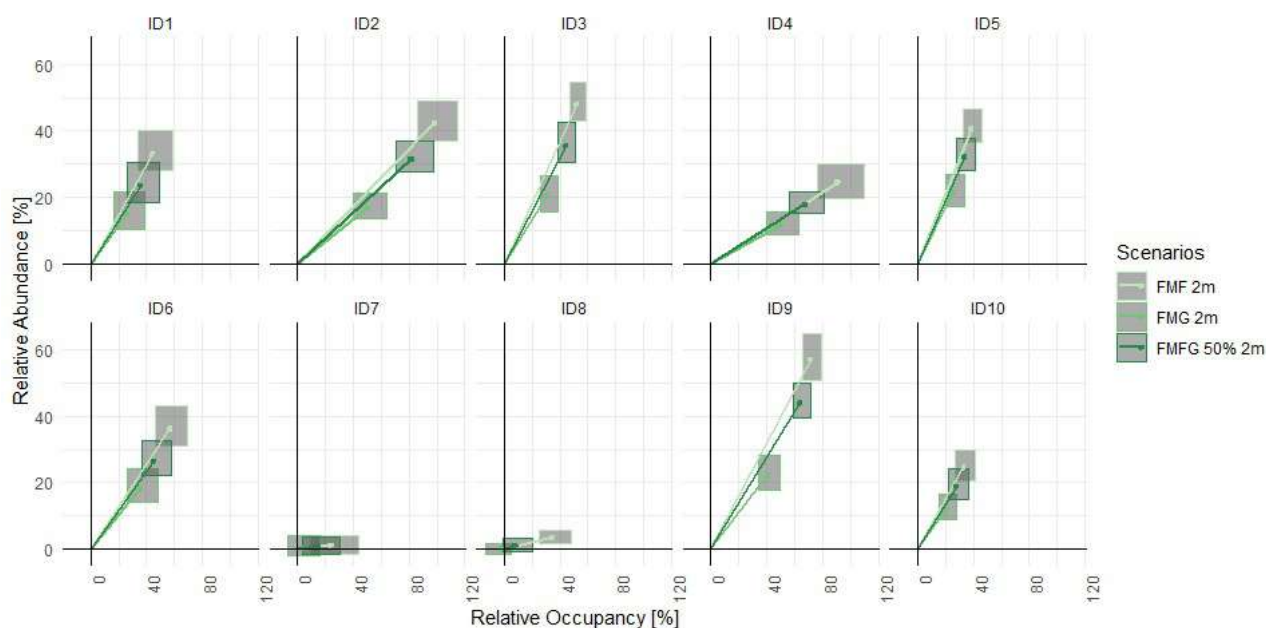


Figure 9.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

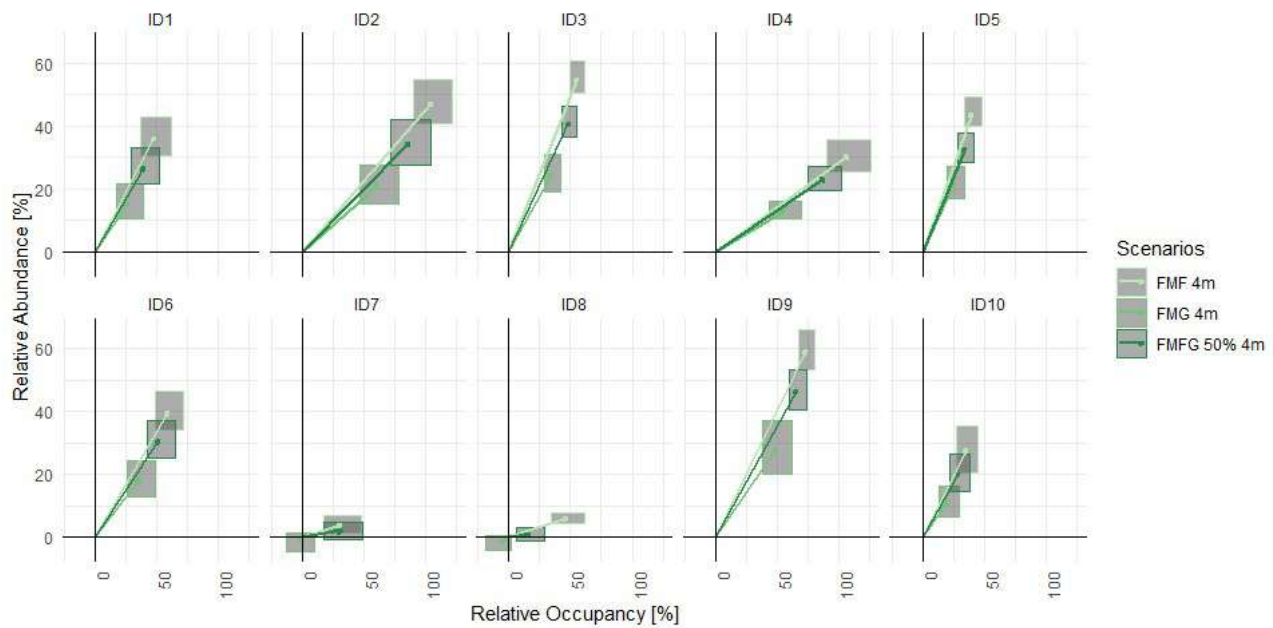


Figure 9.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes..

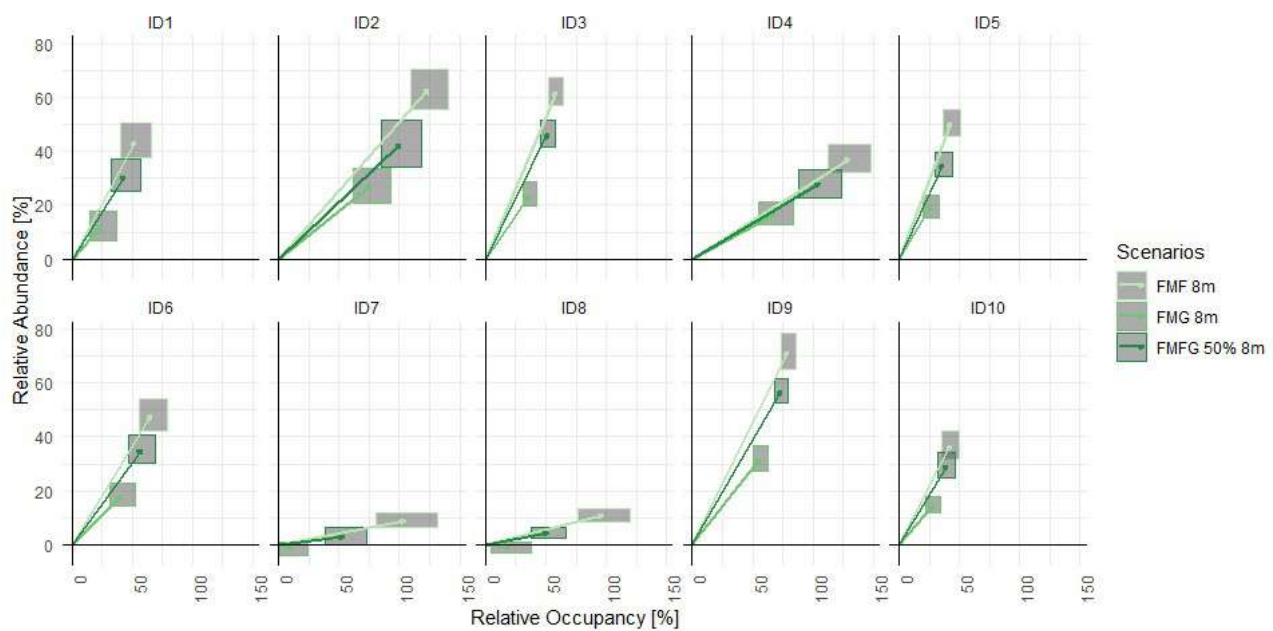


Figure 9.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.6 Setaside

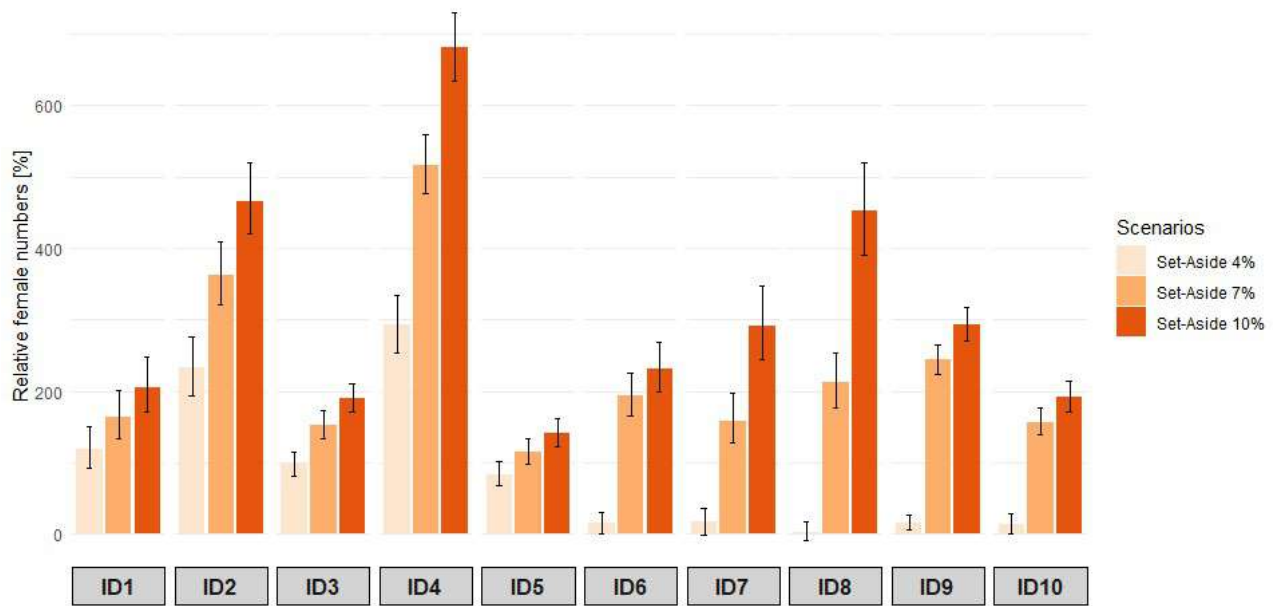


Figure 9.17 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

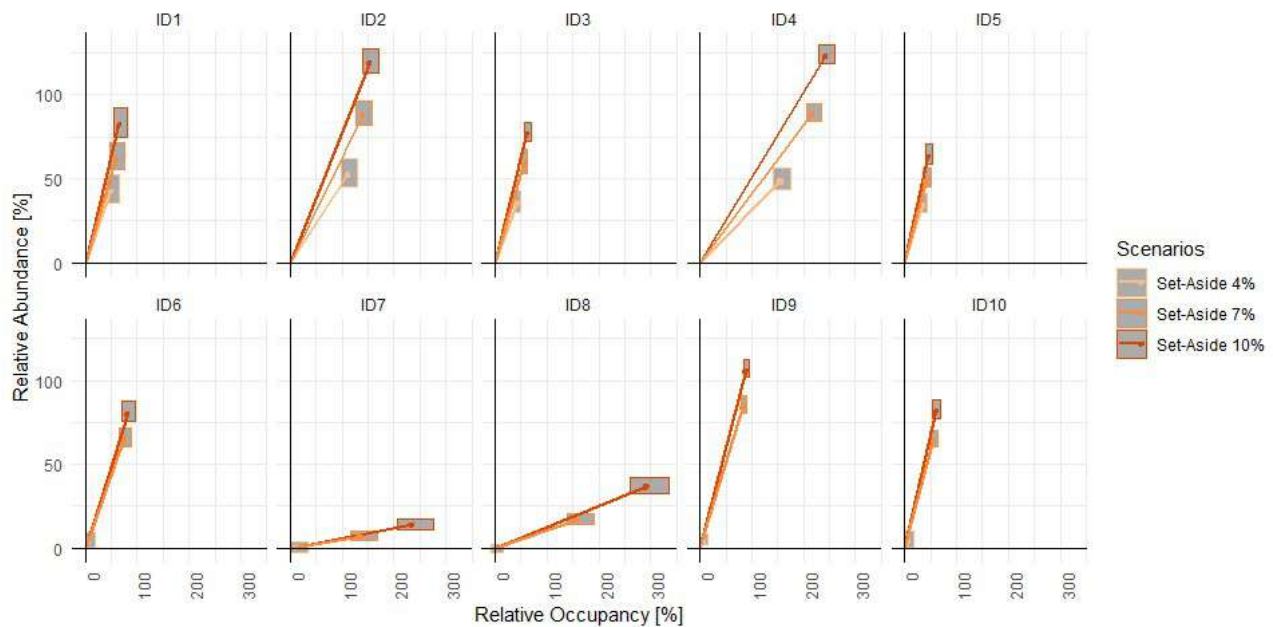


Figure 9.18 Setaside scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.7 Legume

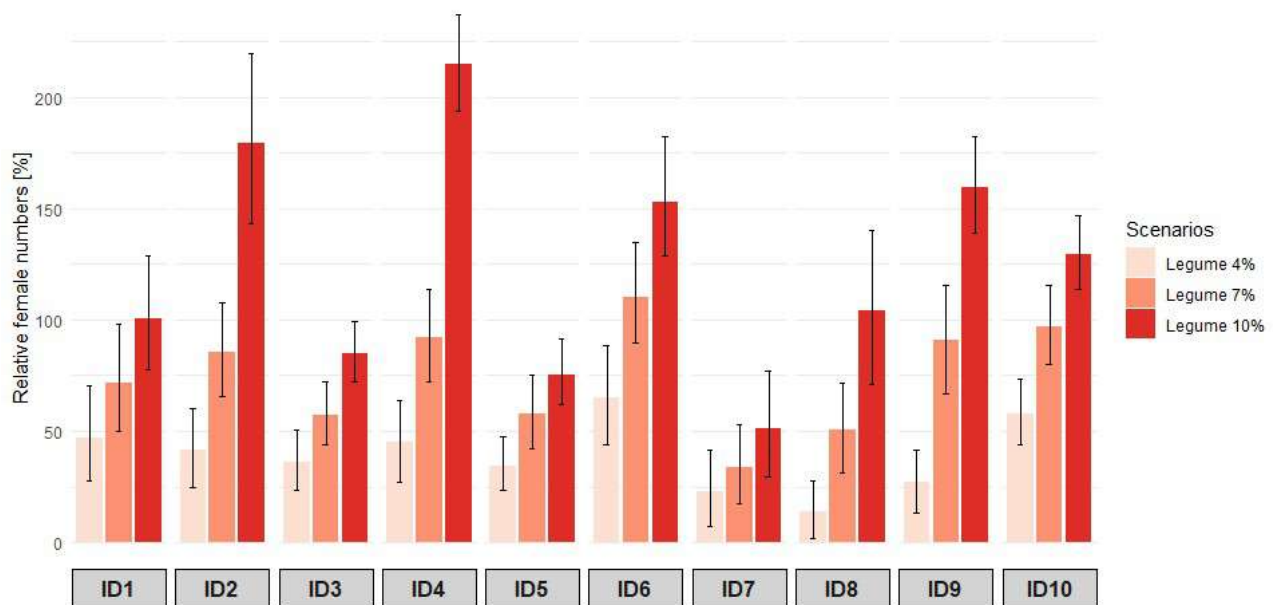


Figure 9.19 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

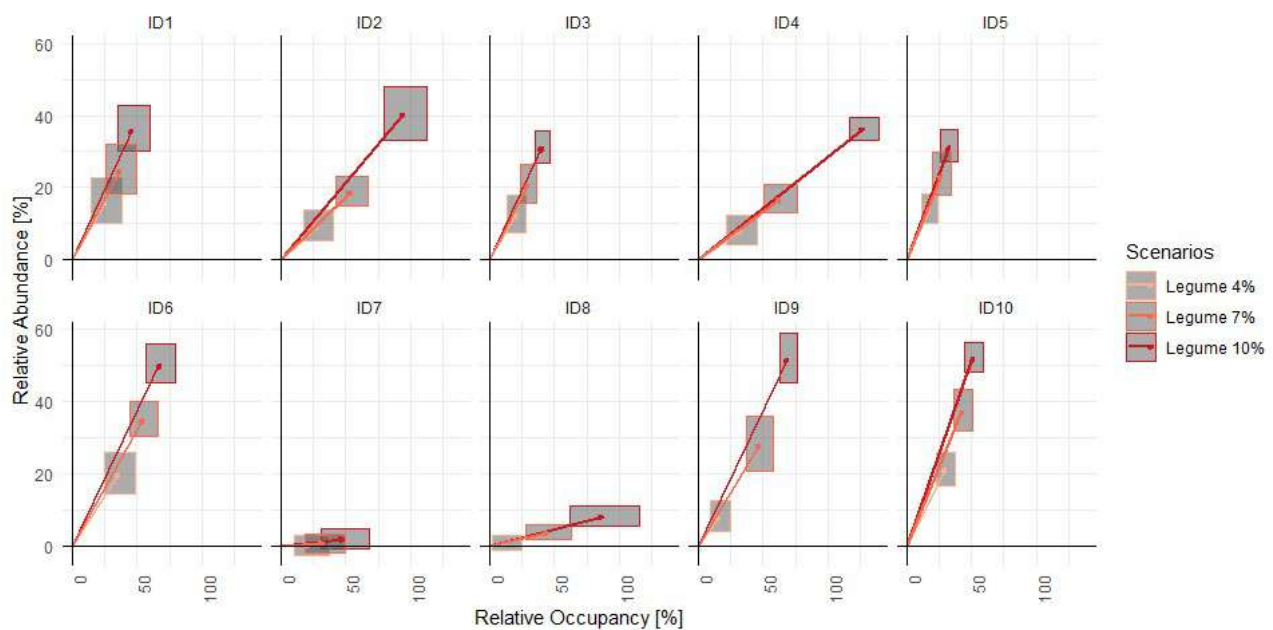


Figure 9.20 Legume scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.2.8 Biopesticides

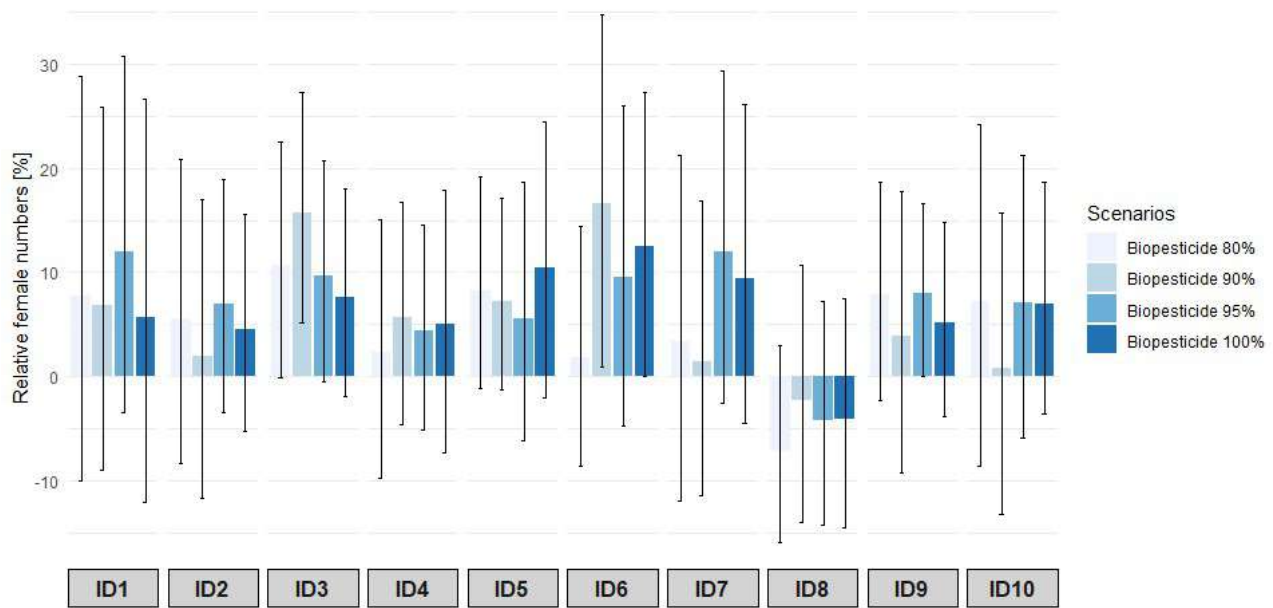


Figure 9.21 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Germany.

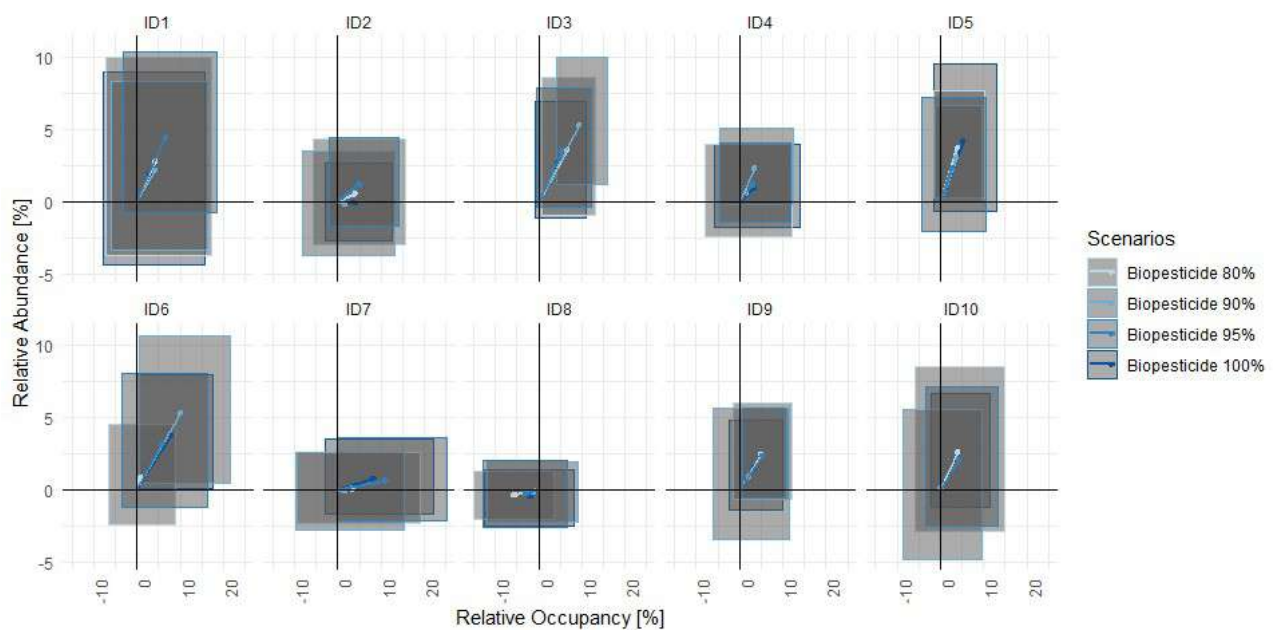


Figure 9.22 Biopesticide scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Germany at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3 Denmark

9.3.1 Crop diversification

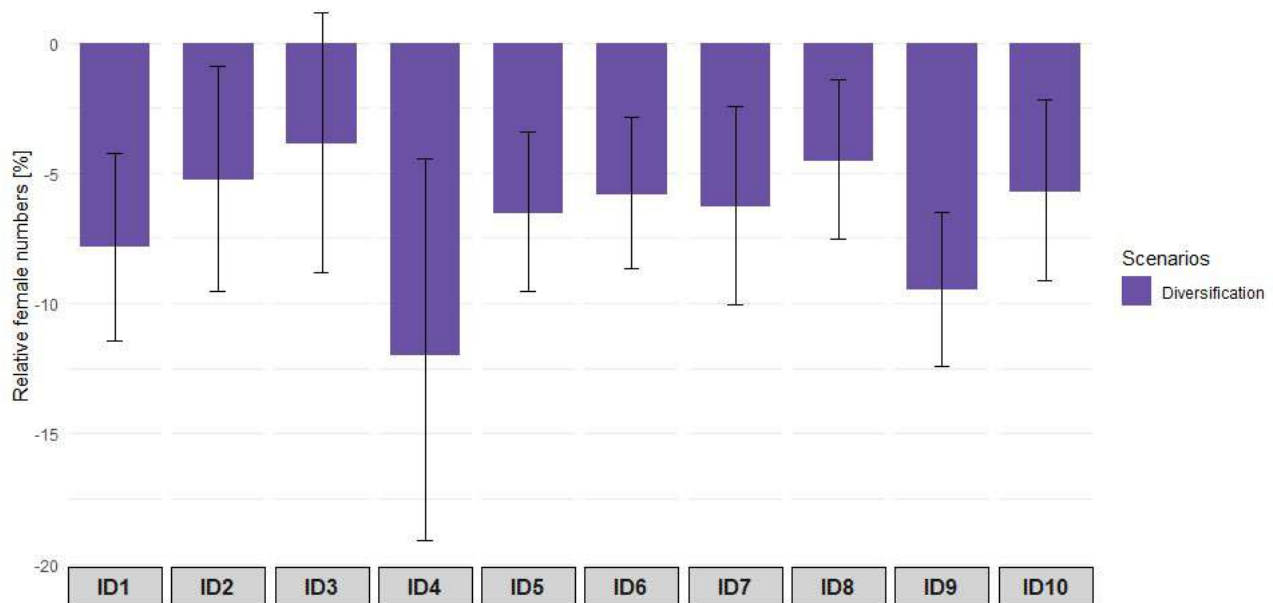


Figure 9.23 Diversification scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

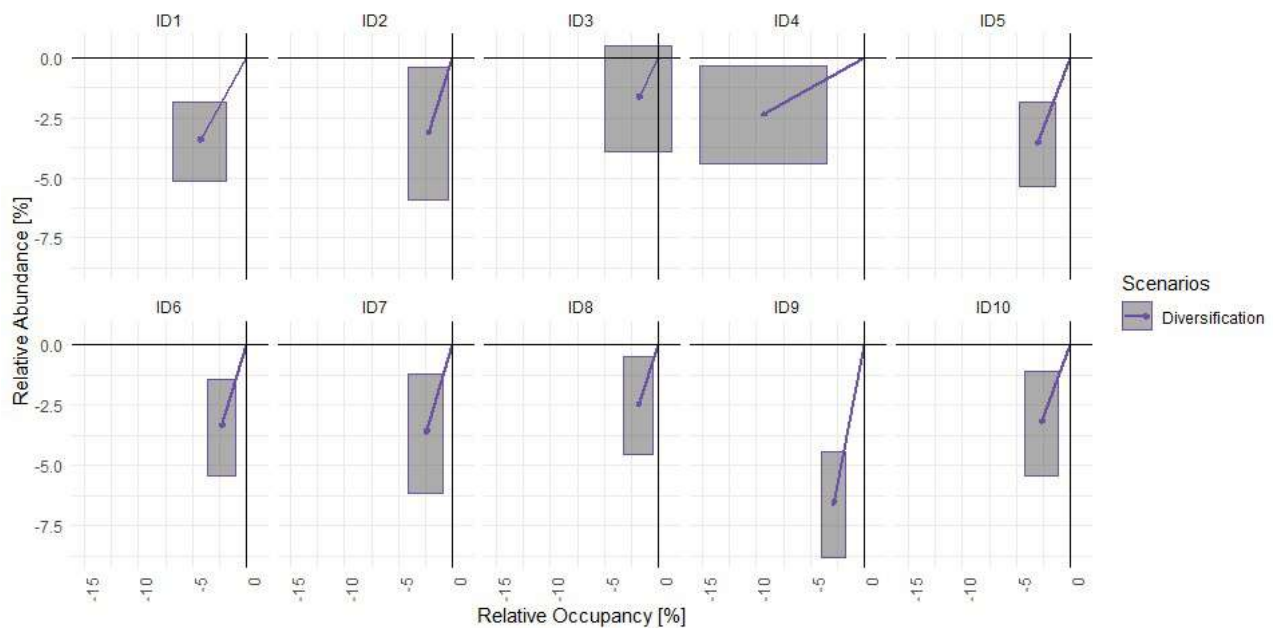


Figure 9.24 Diversification scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.2 Flower field margins

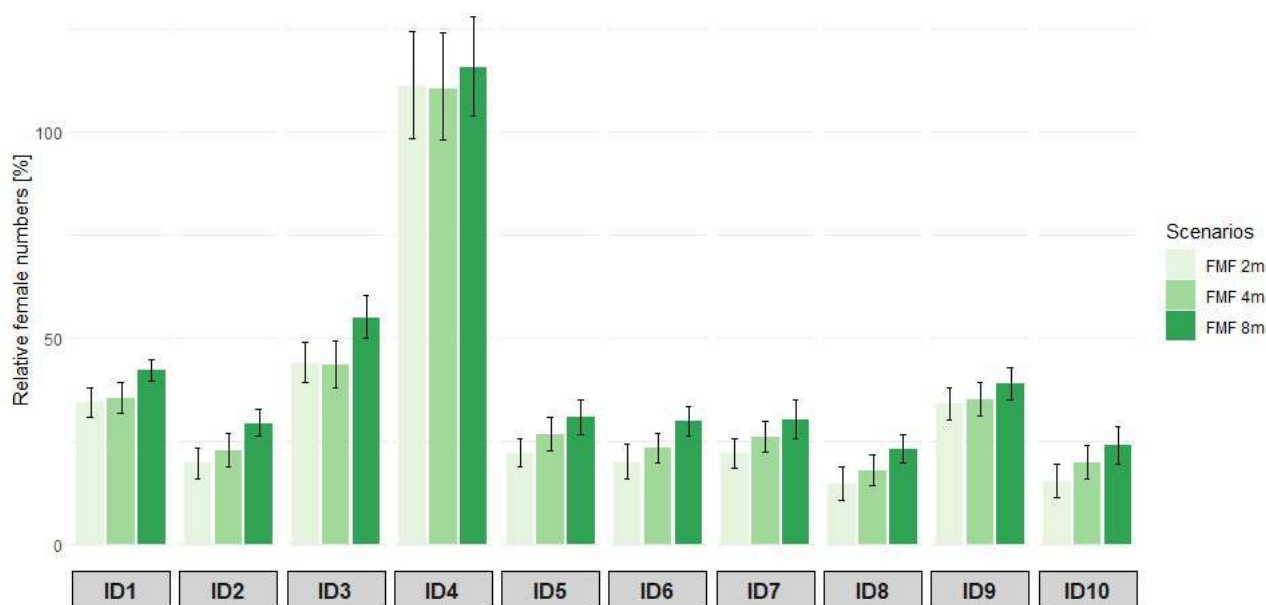


Figure 9.25 Flower field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

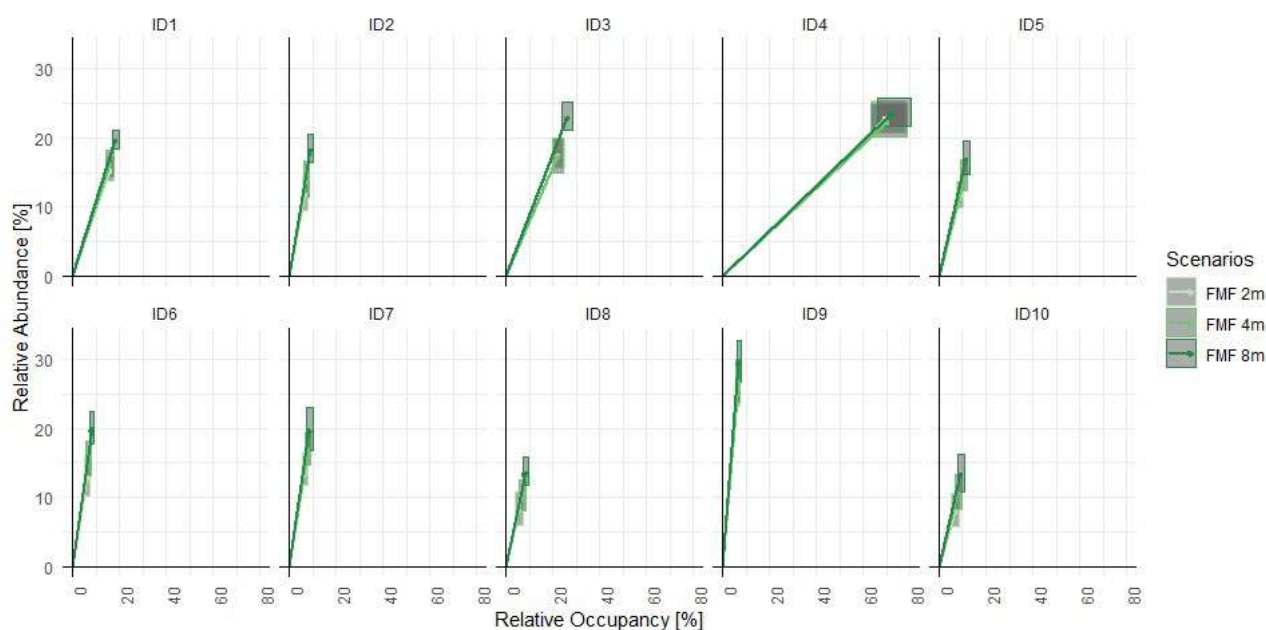


Figure 9.26 Flower field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.3 Grassy field margins

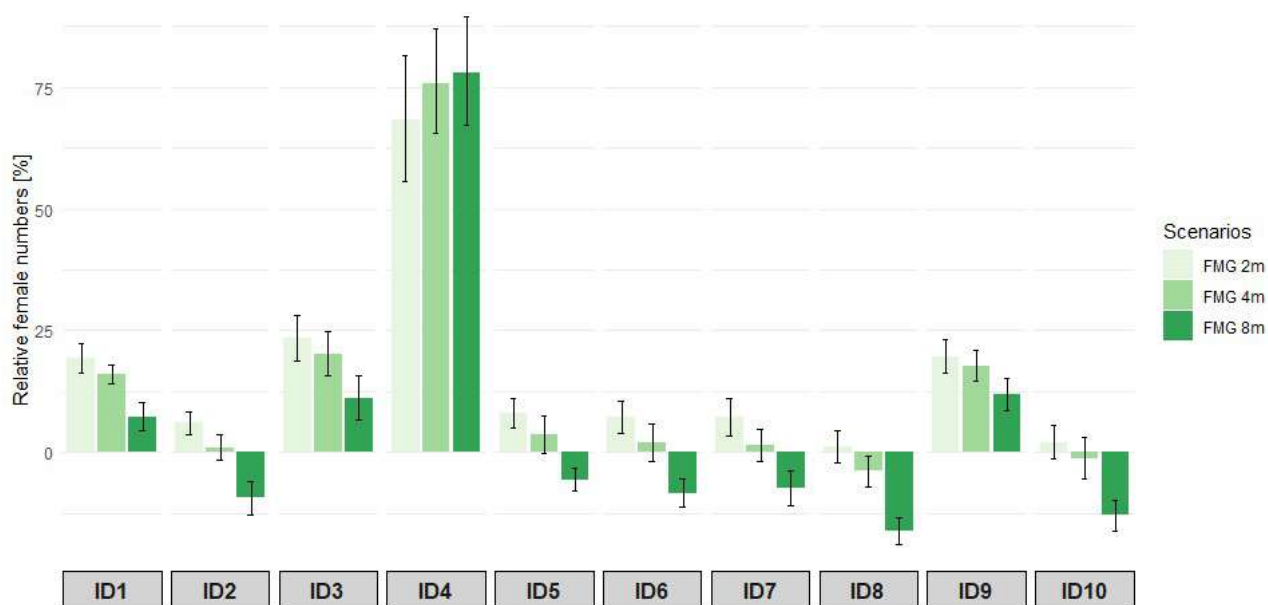


Figure 9.27 Grassy field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

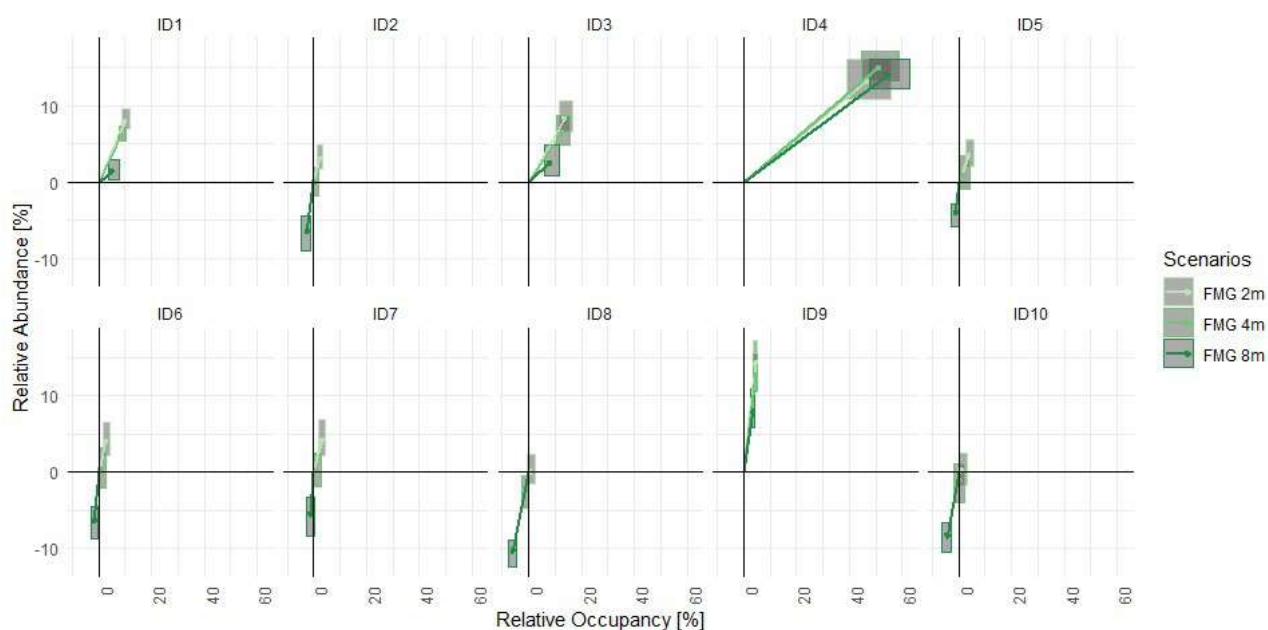


Figure 9.28 Grassy field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.4 Mixed field margins

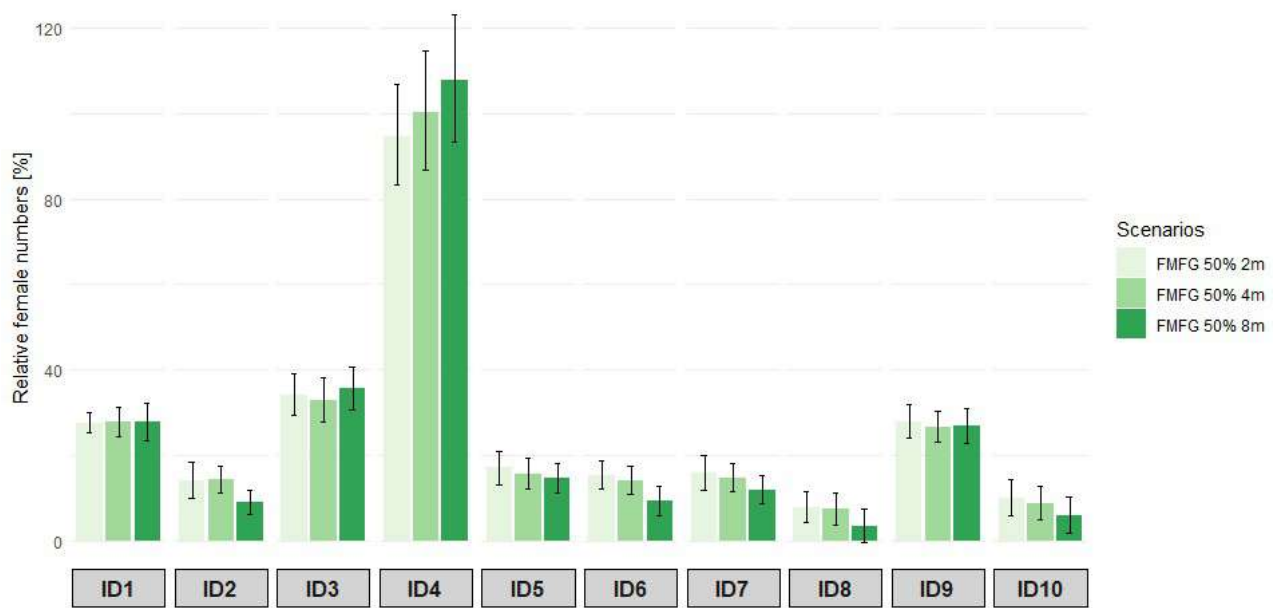


Figure 9.29 Mixed field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

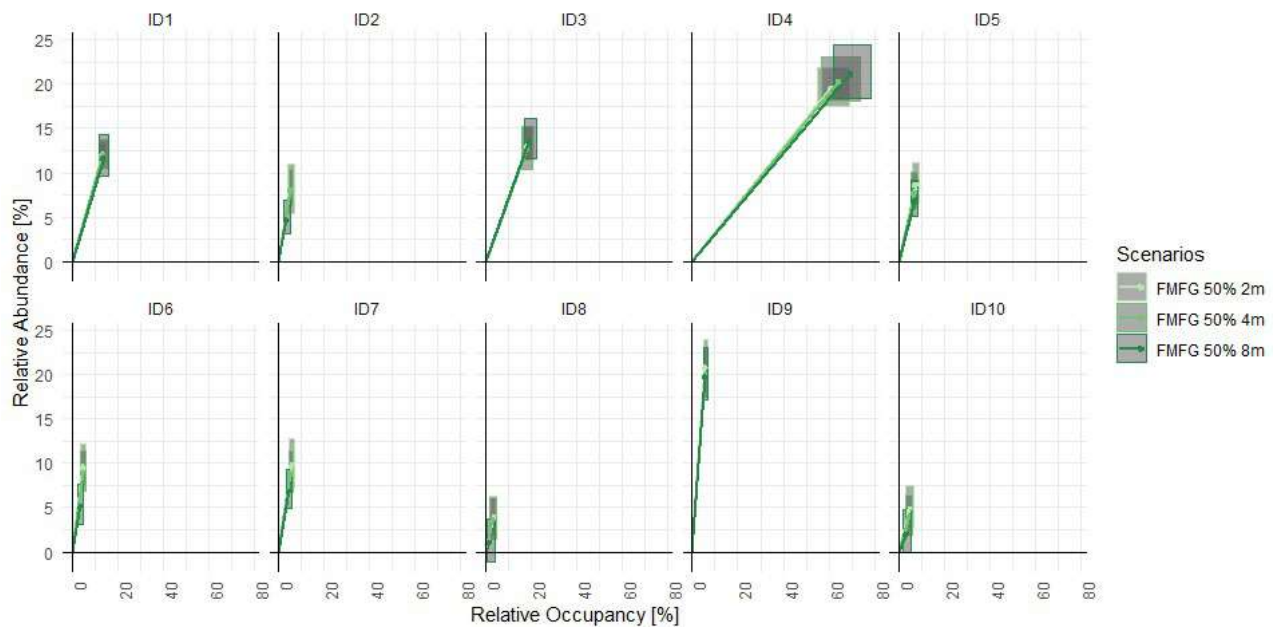


Figure 9.30 Mixed field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.5 Flower, grassy and mixed field margins

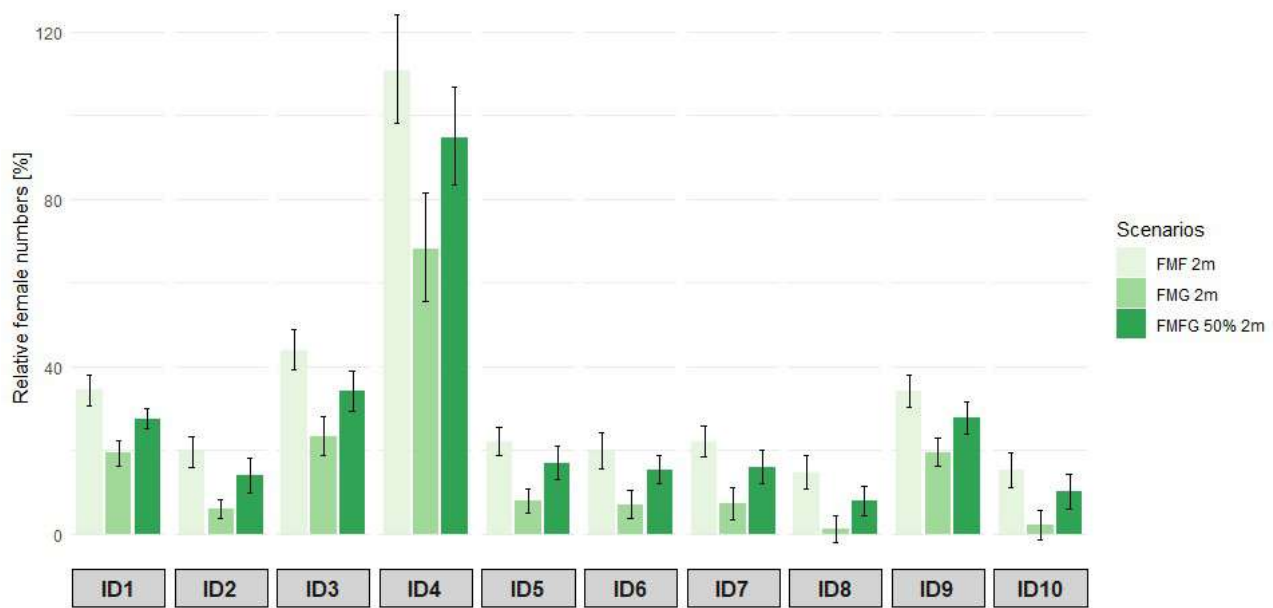


Figure 9.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

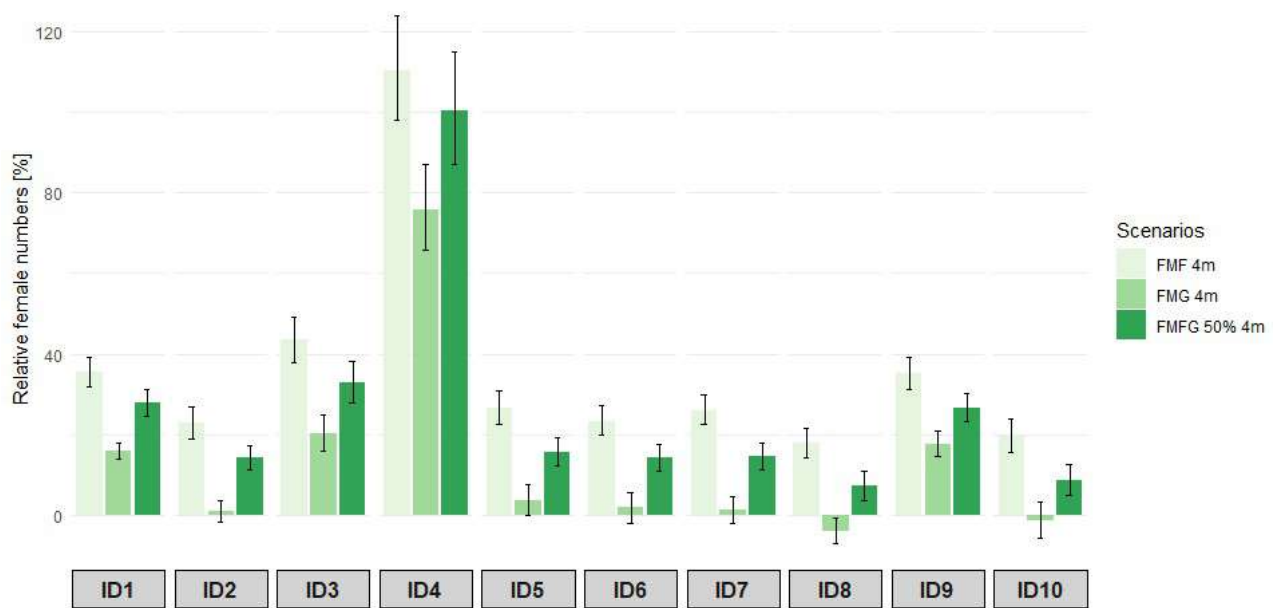


Figure 9.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

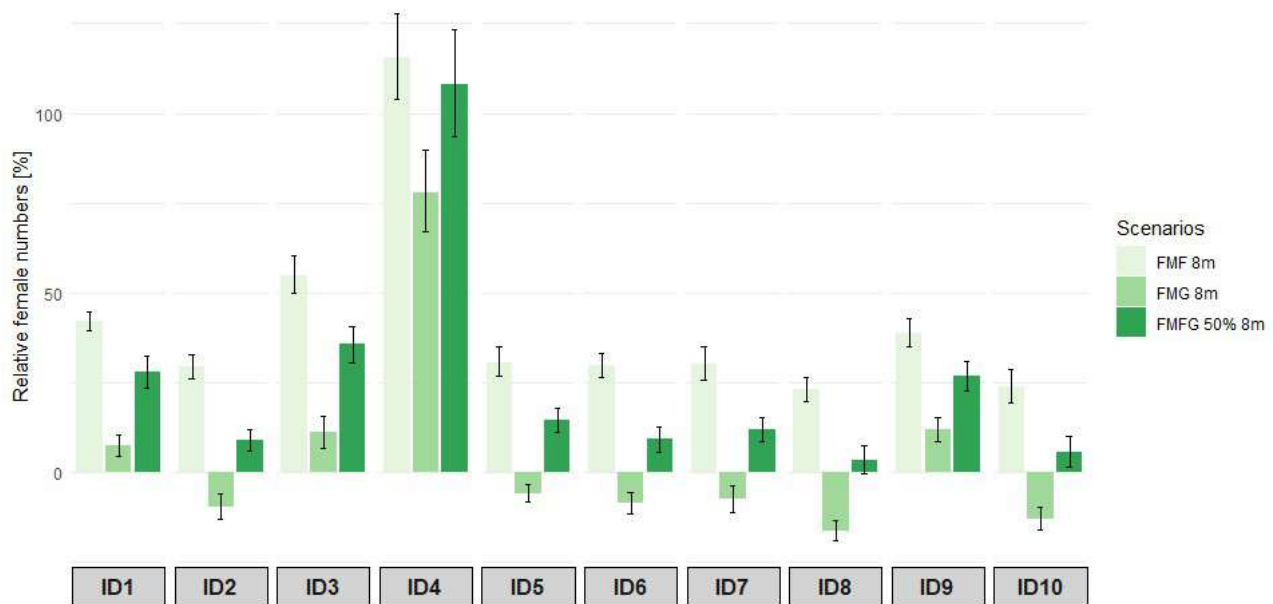


Figure 9.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

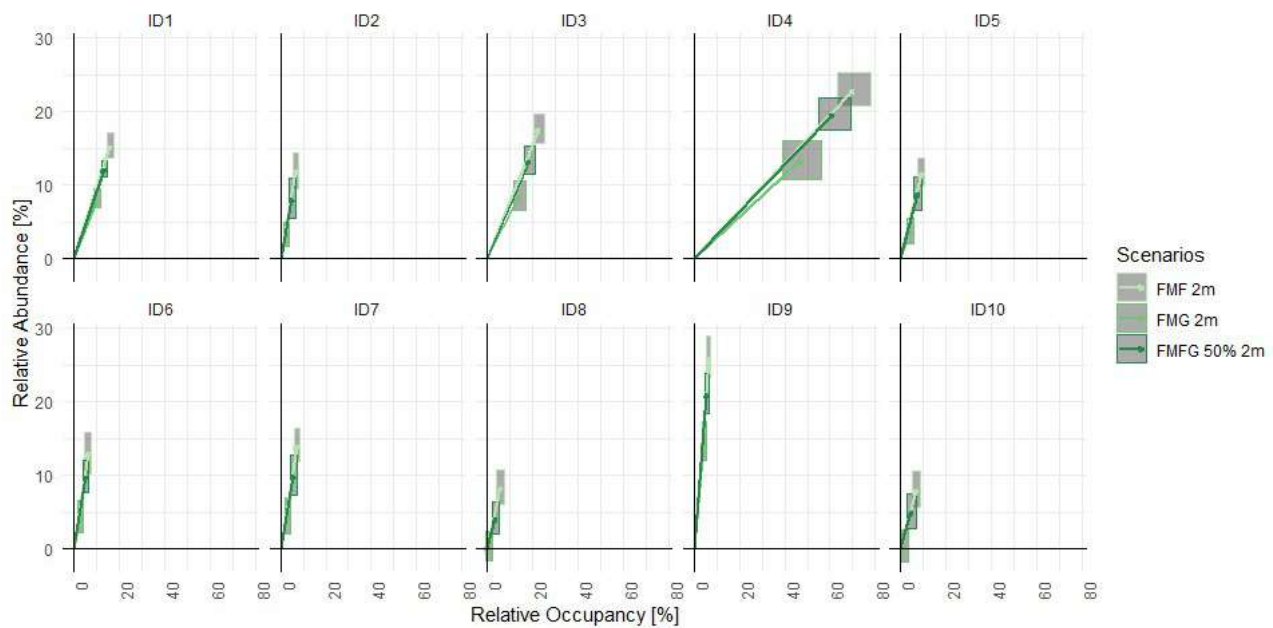


Figure 9.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

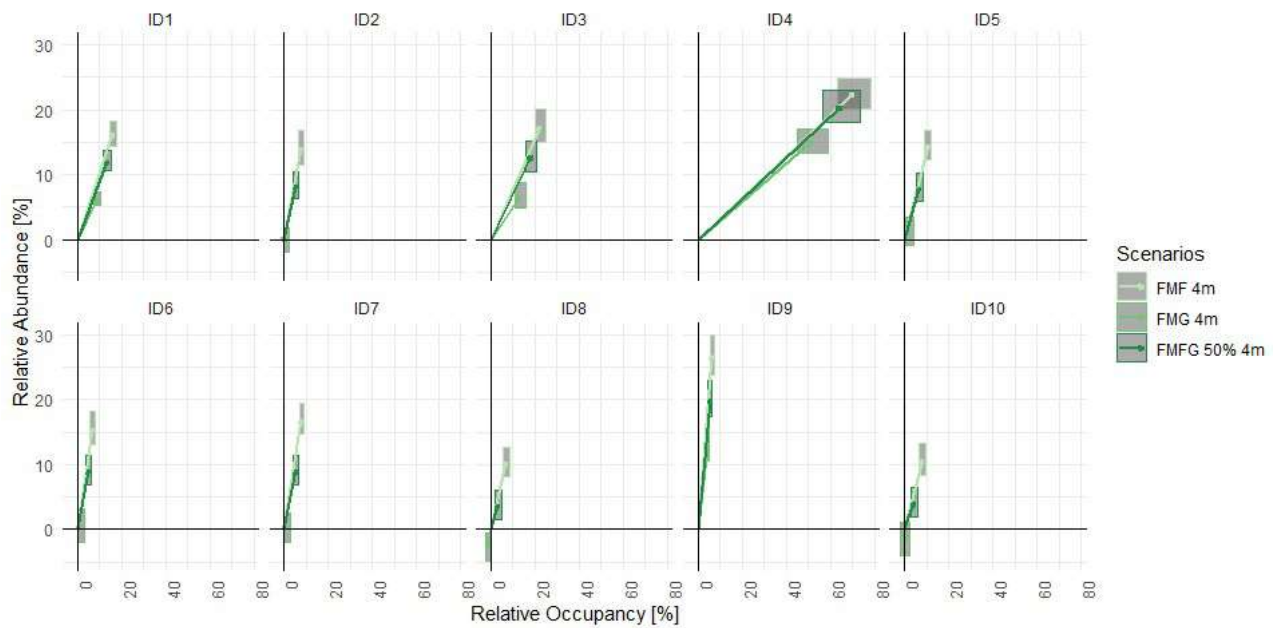


Figure 9.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes..

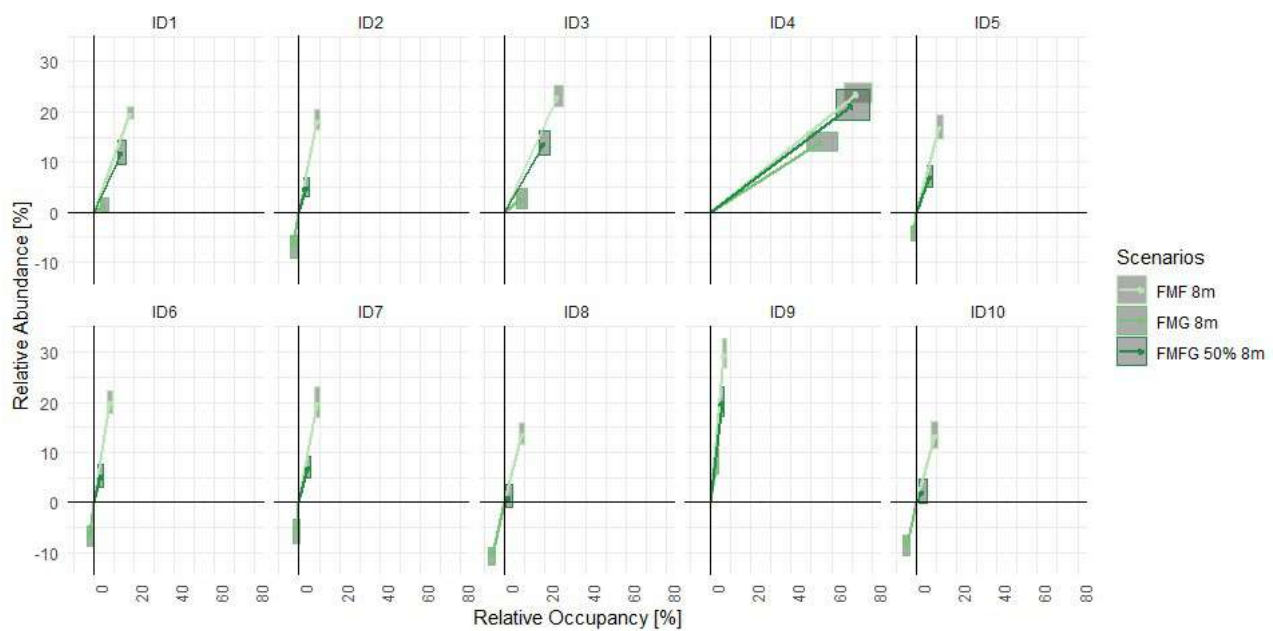


Figure 9.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.6 Setaside

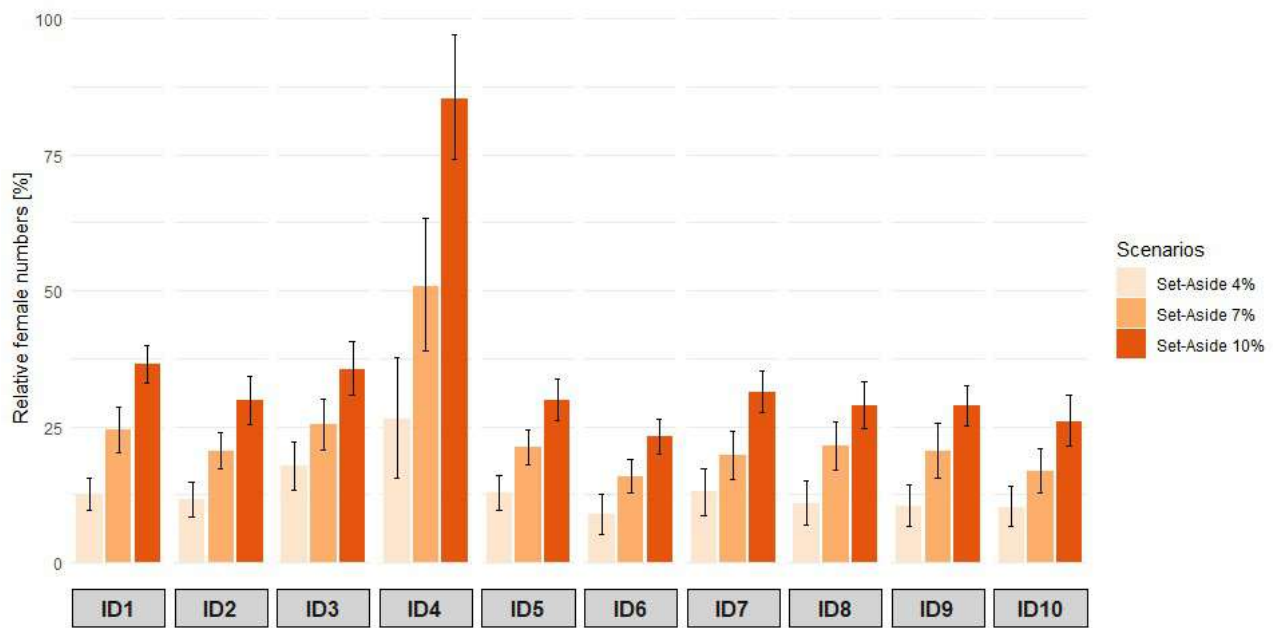


Figure 9.37 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

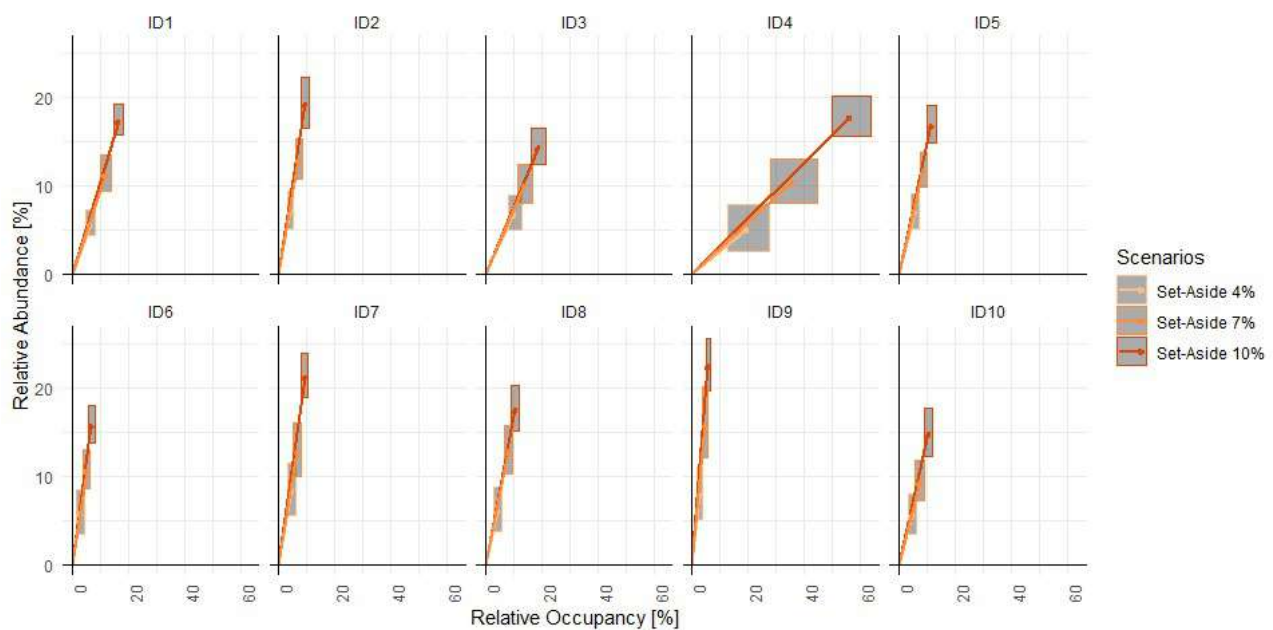


Figure 9.38 Setaside scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.7 Legume

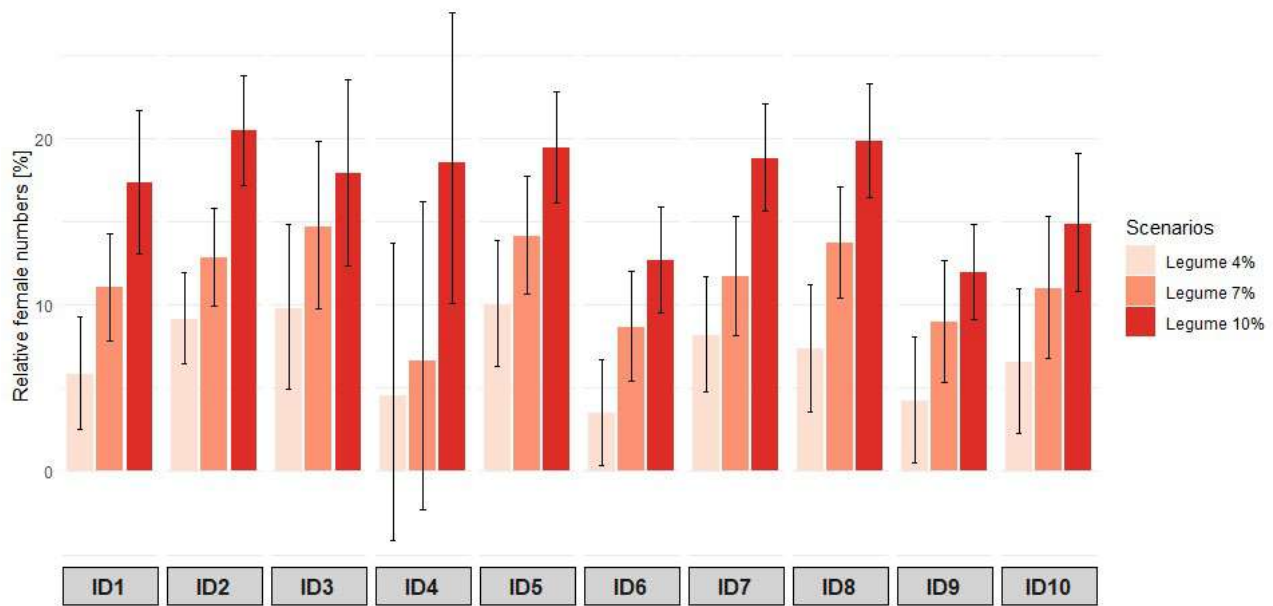


Figure 9.39 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

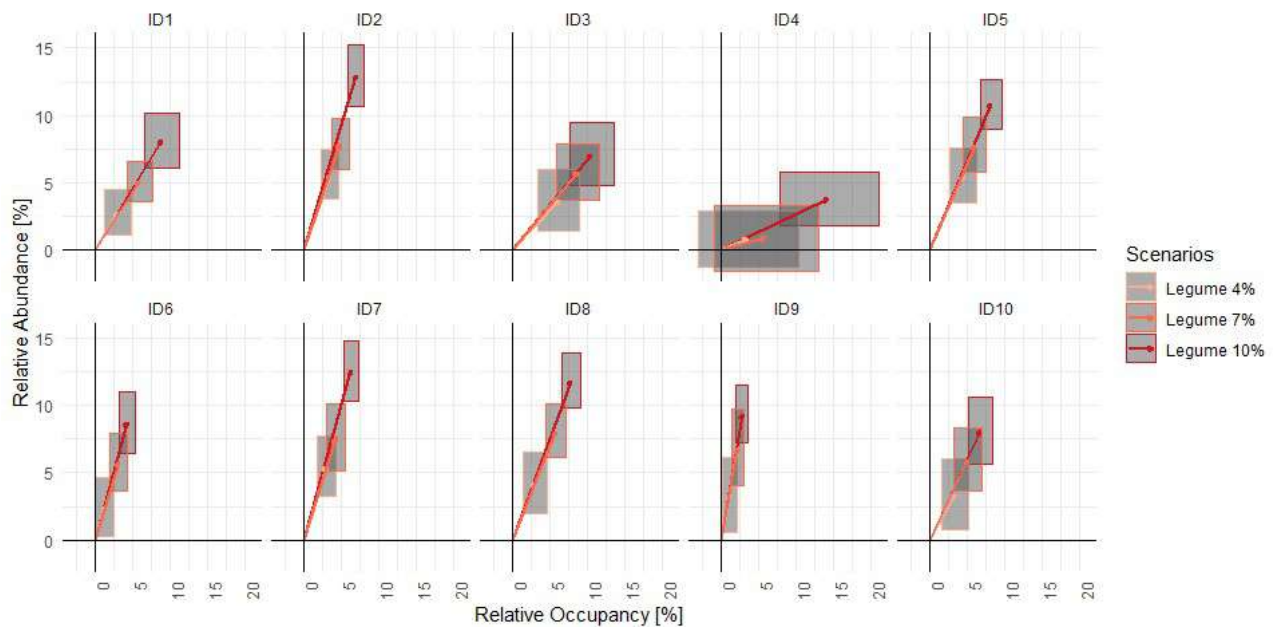


Figure 9.40 Legume scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.3.8 Biopesticides

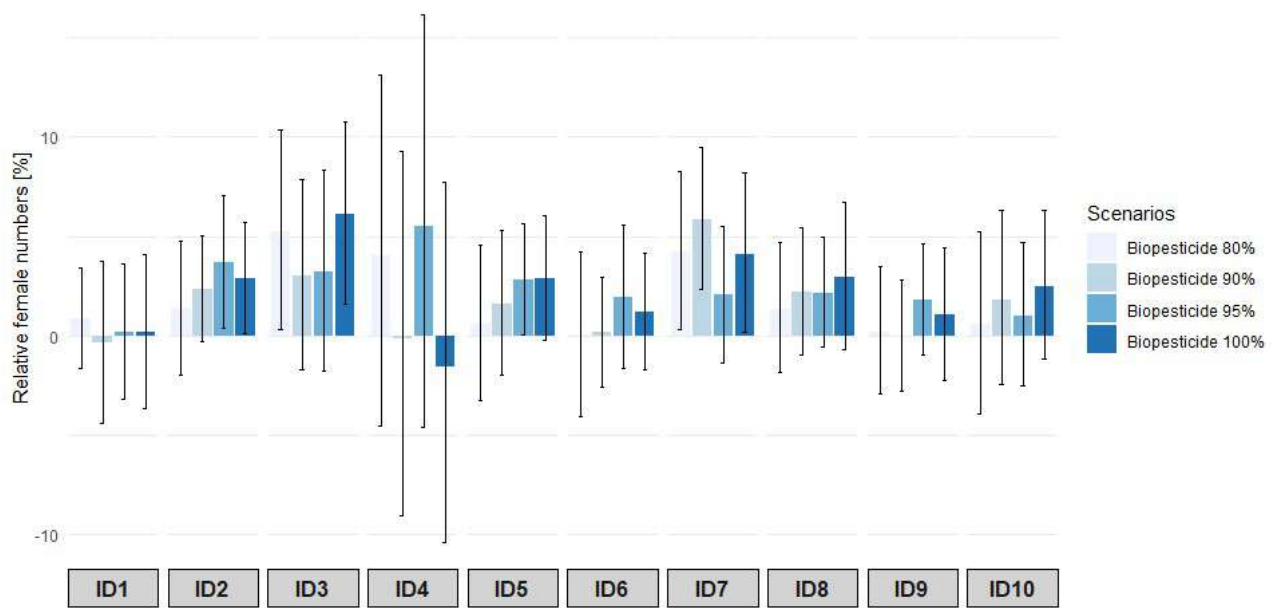


Figure 9.41 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

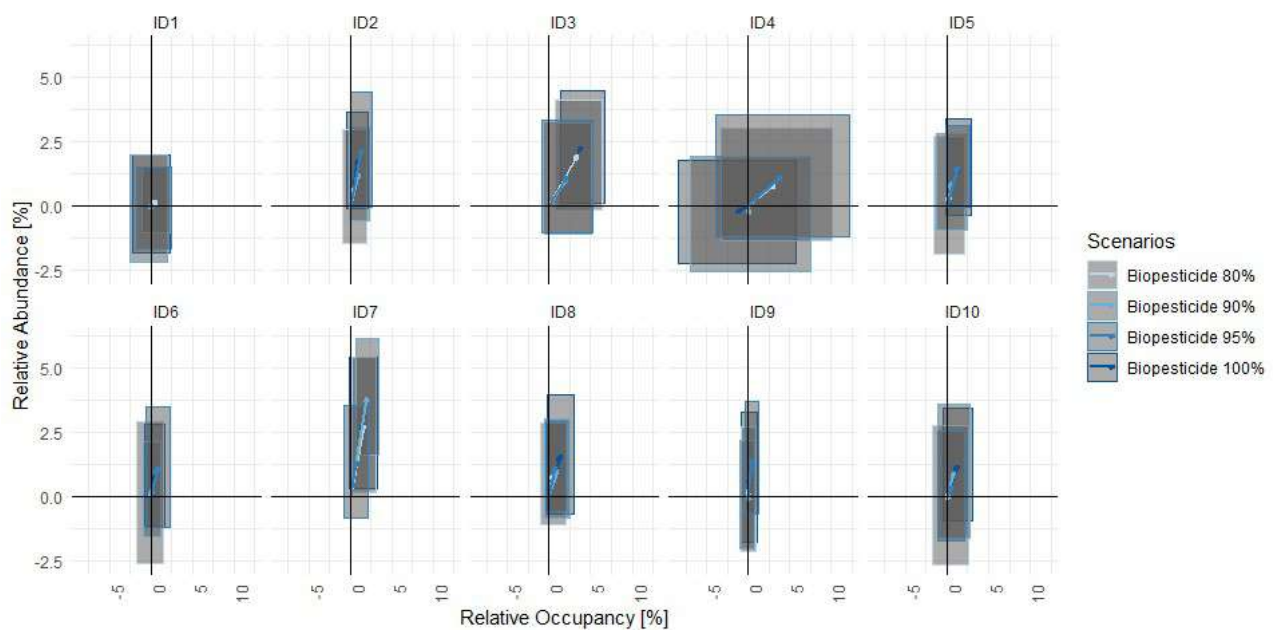


Figure 9.42 Biopesticide scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Denmark at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4 Poland

9.4.1 Flower field margins

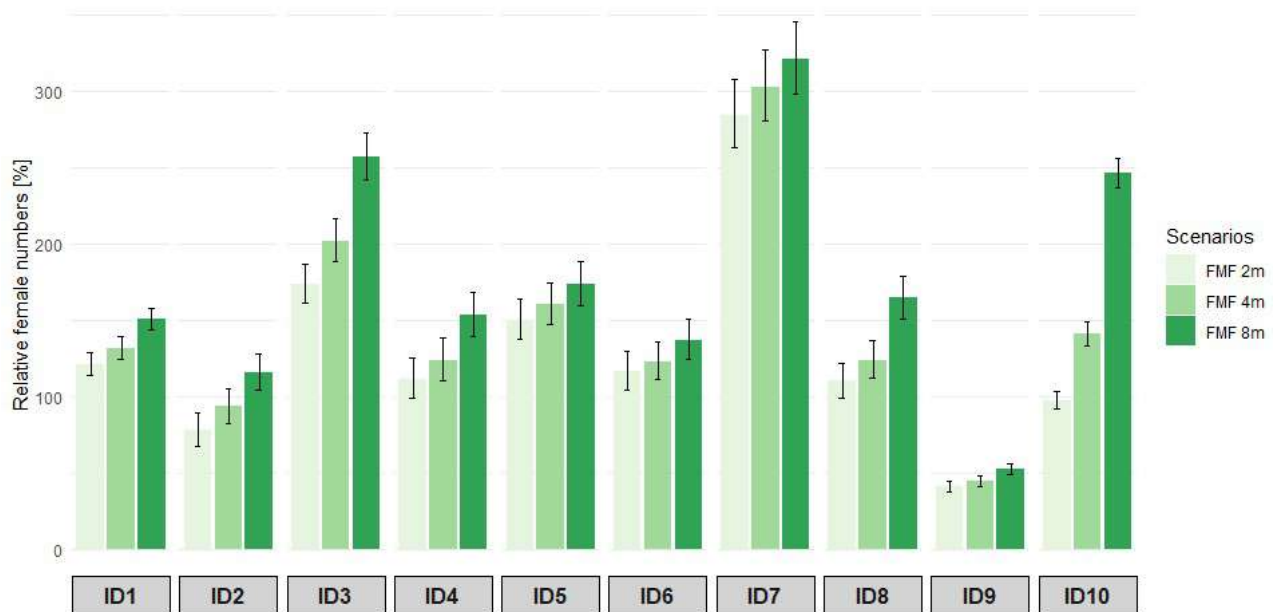


Figure 9.43 Flower field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

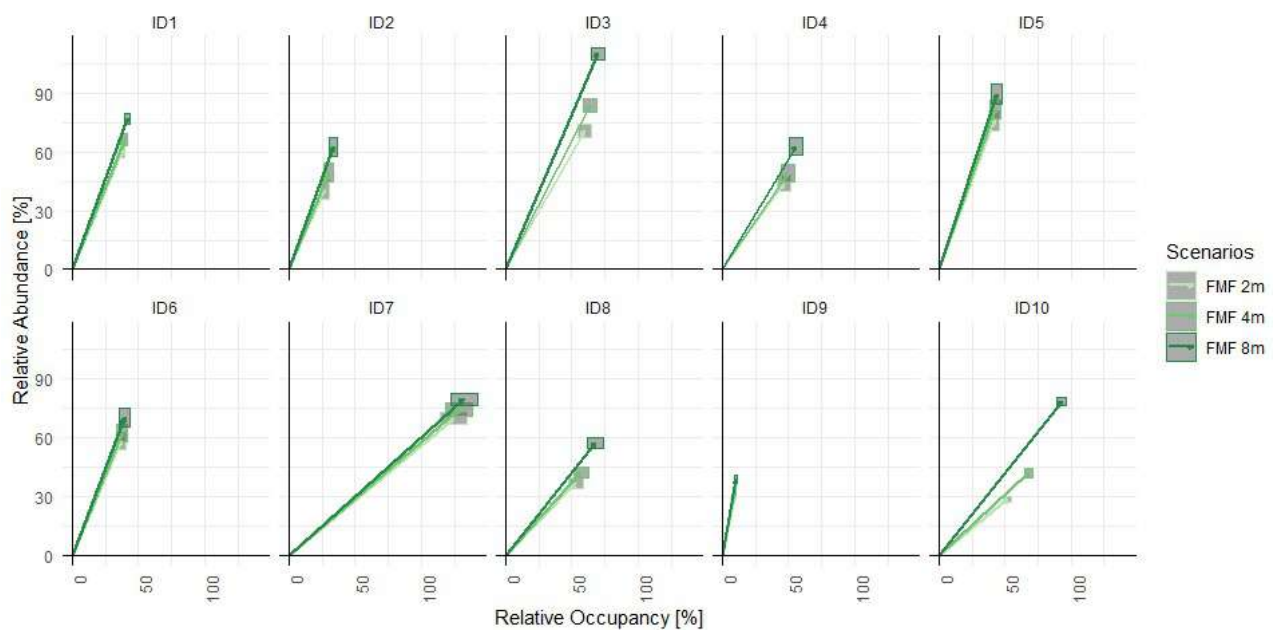


Figure 9.44 Flower field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4.2 Grassy field margins

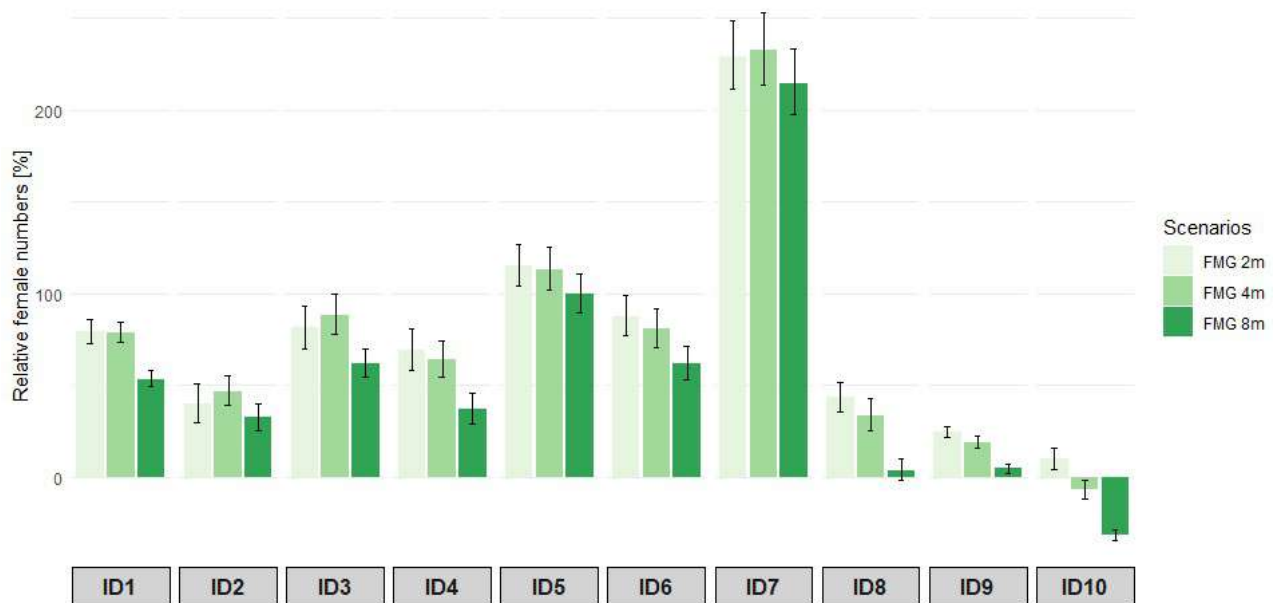


Figure 9.45 Grassy field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

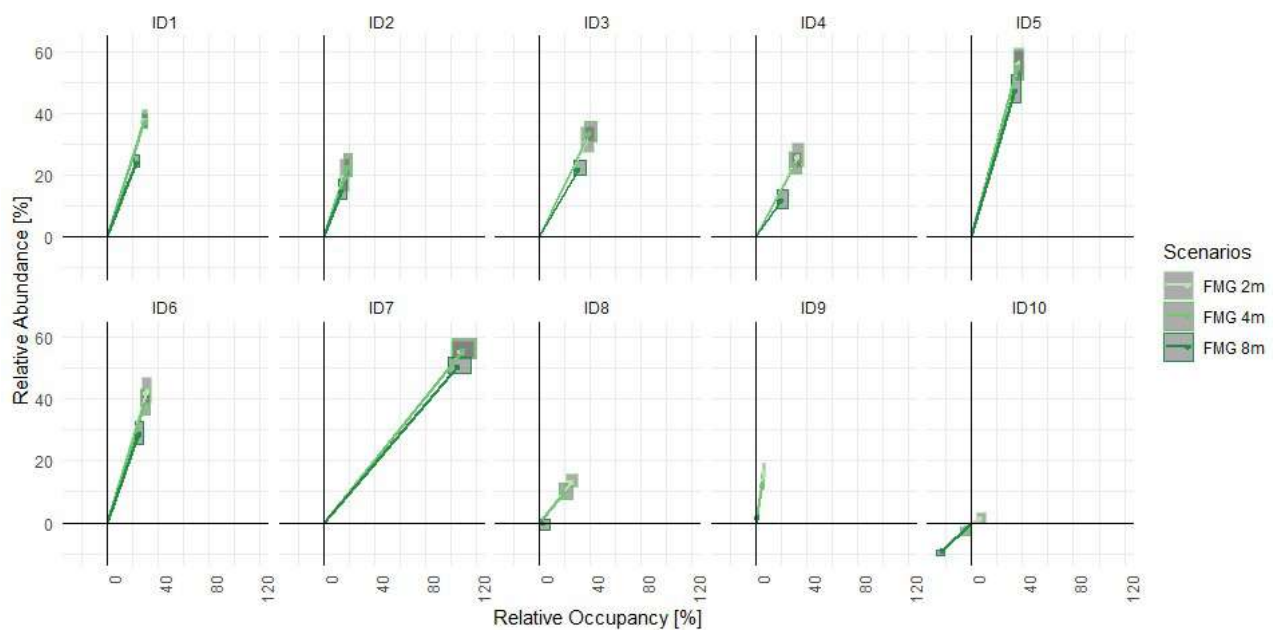


Figure 9.46 Grassy field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4.3 Mixed field margins

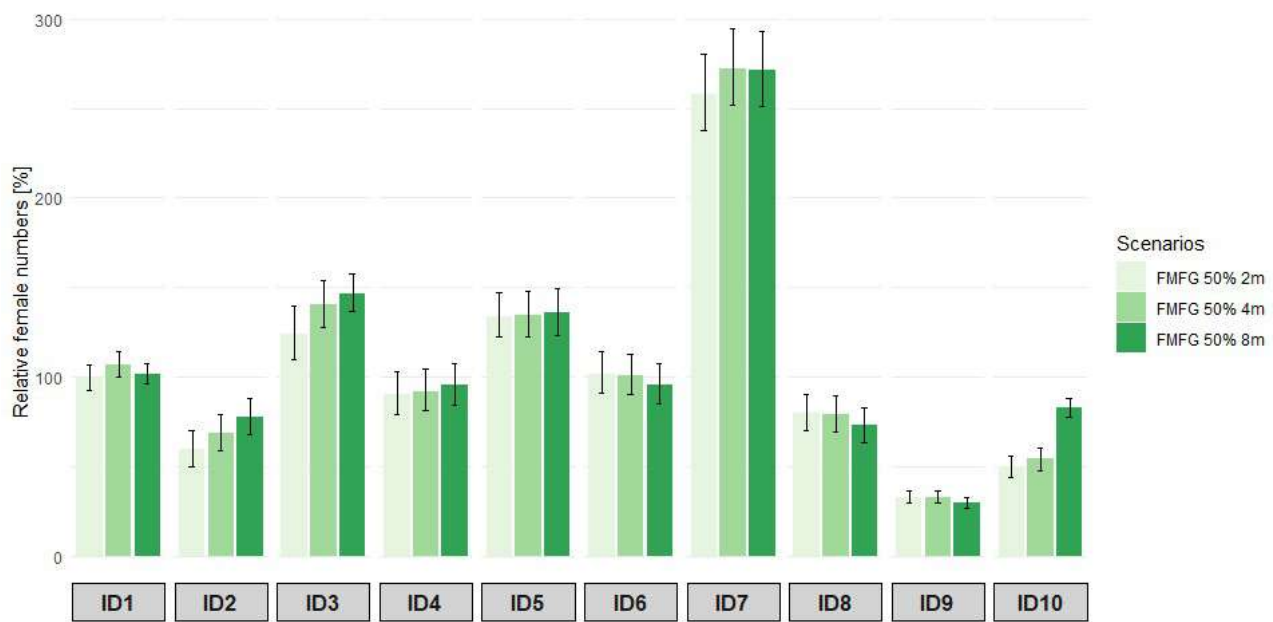


Figure 9.47 Mixed field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

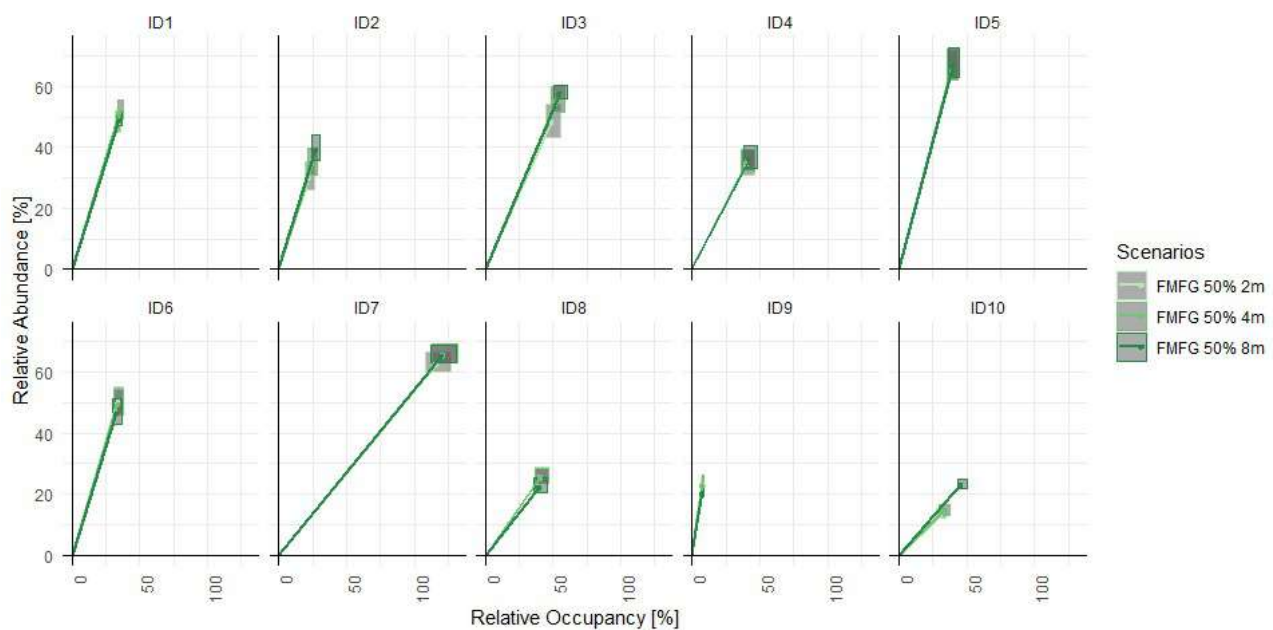


Figure 9.48 Mixed field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4.4 Flower, grassy and mixed field margins

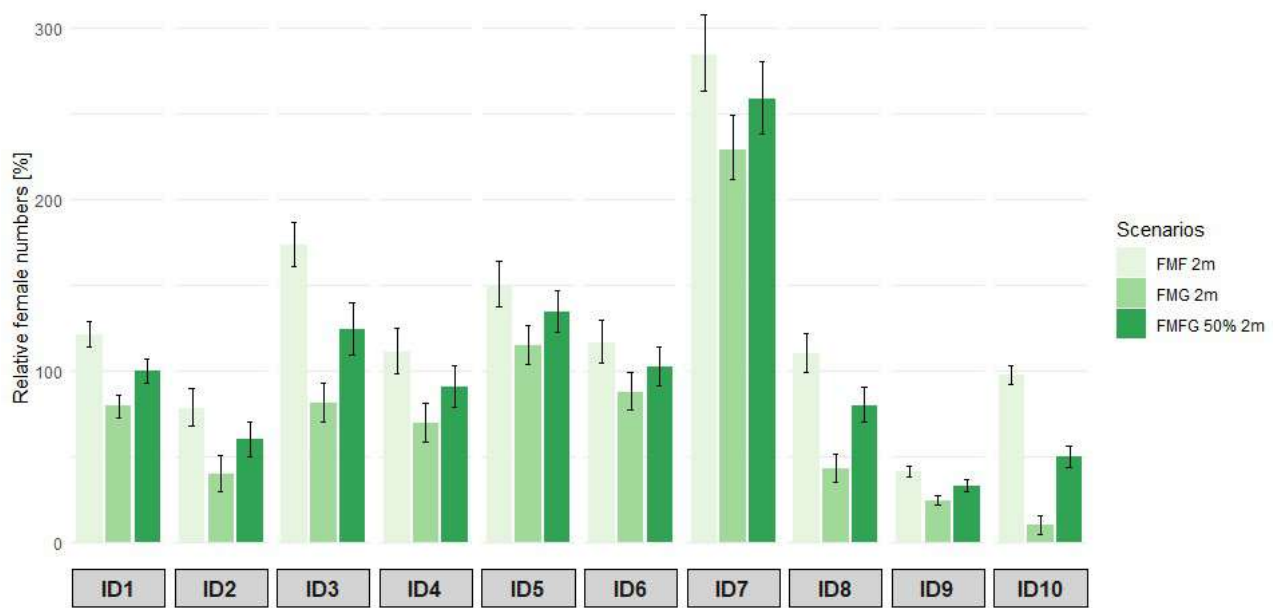


Figure 9.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

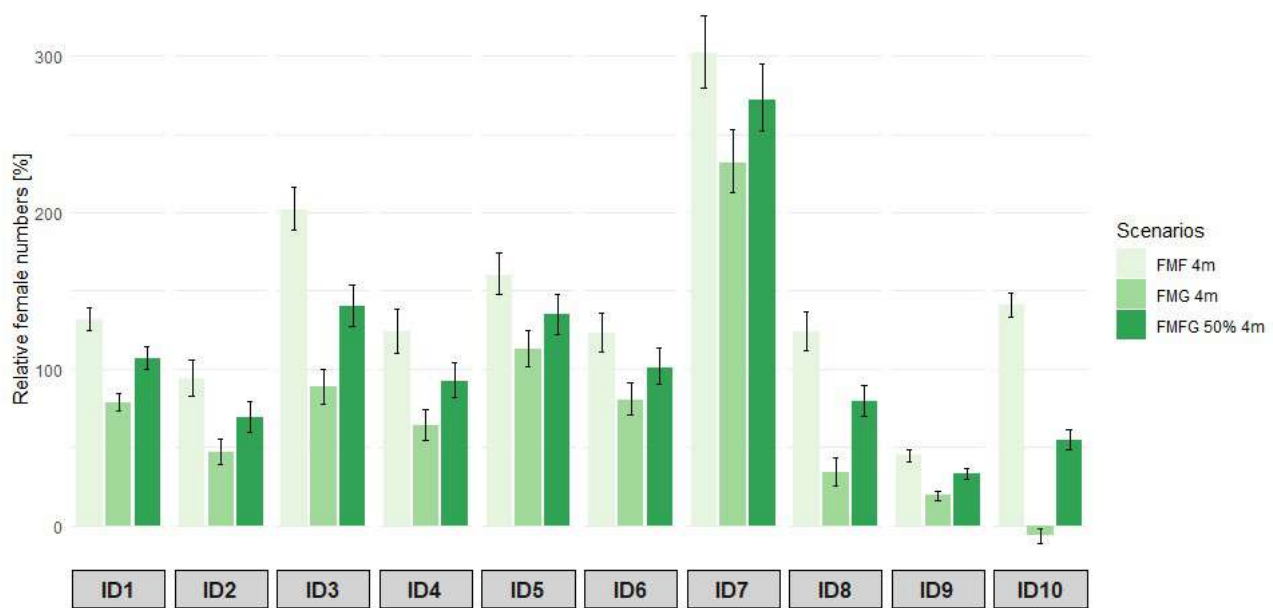


Figure 9.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

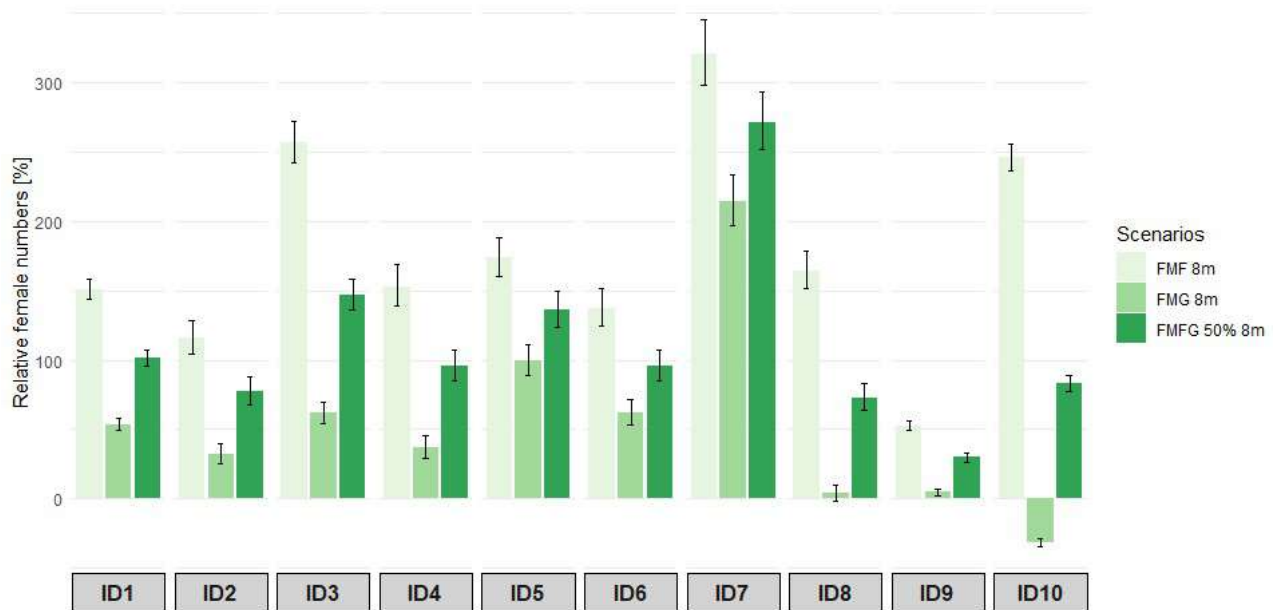


Figure 9.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

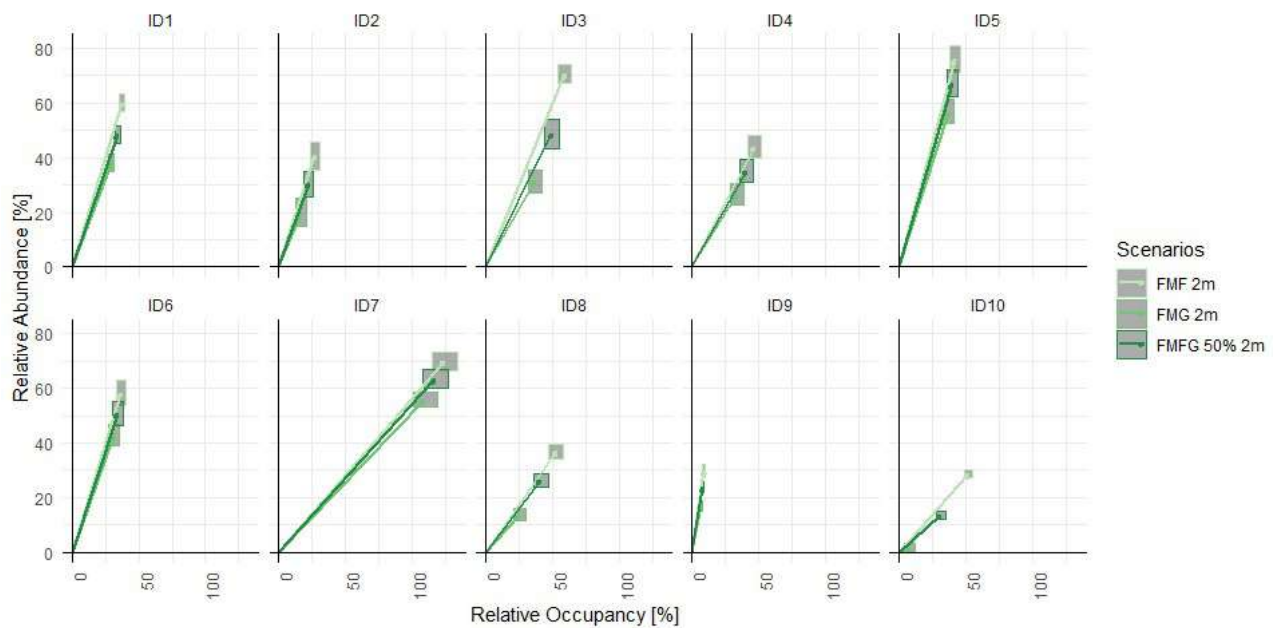


Figure 9.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

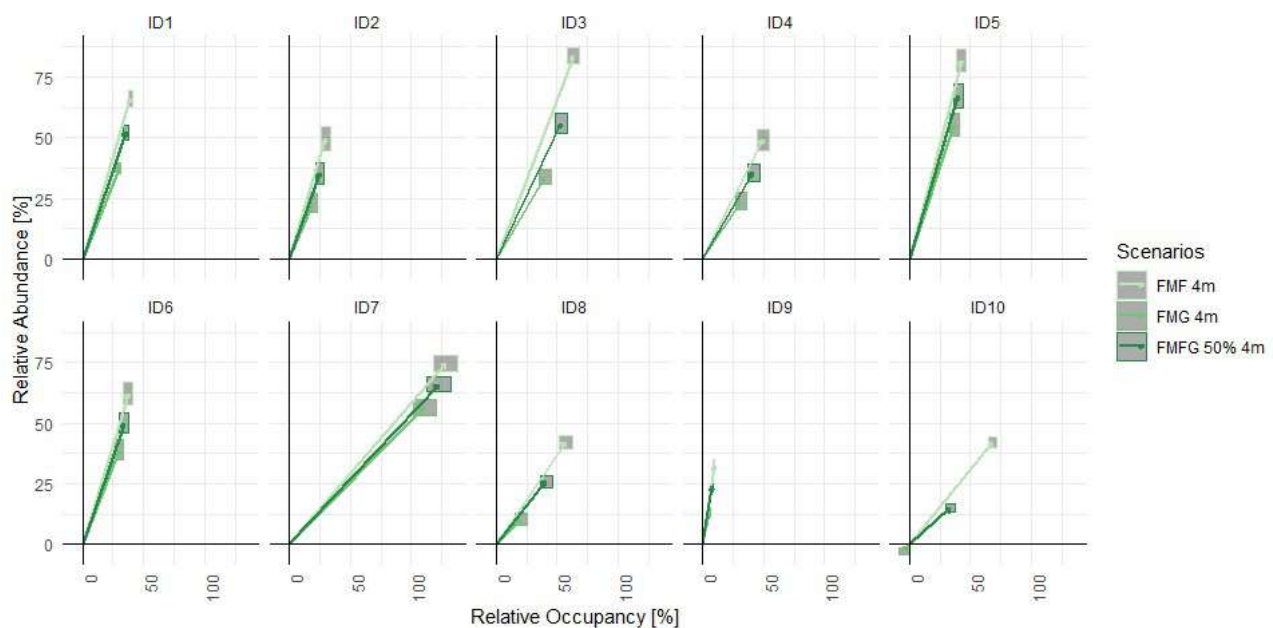


Figure 9.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes..

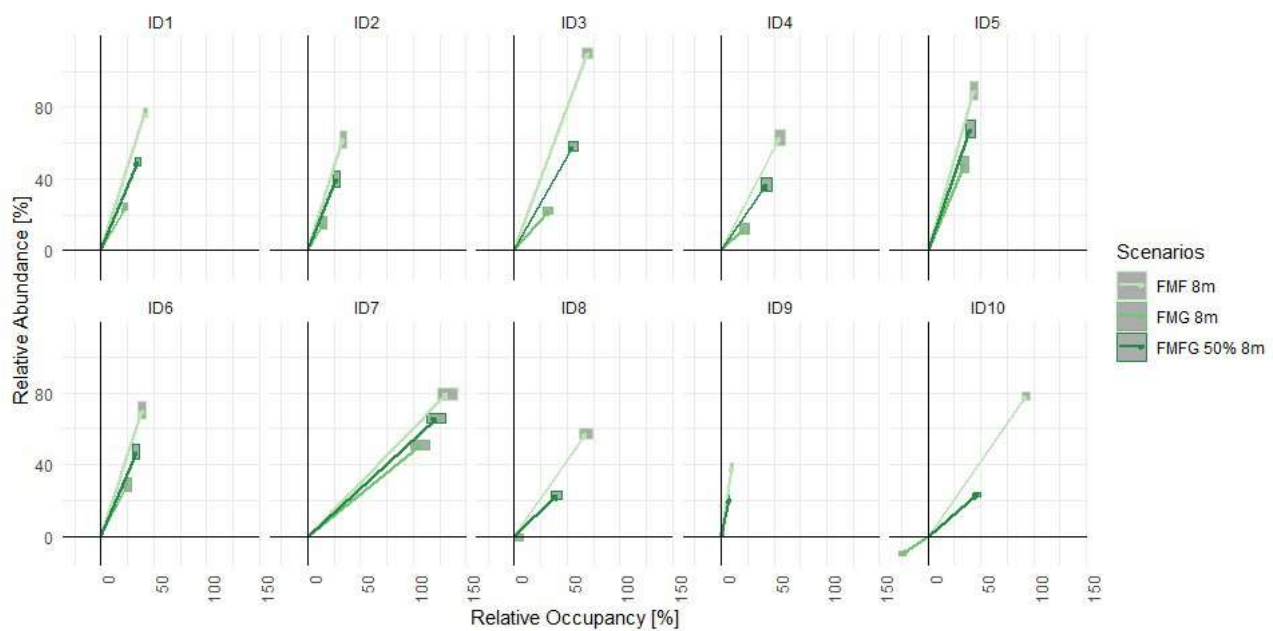


Figure 9.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4.5 Setaside

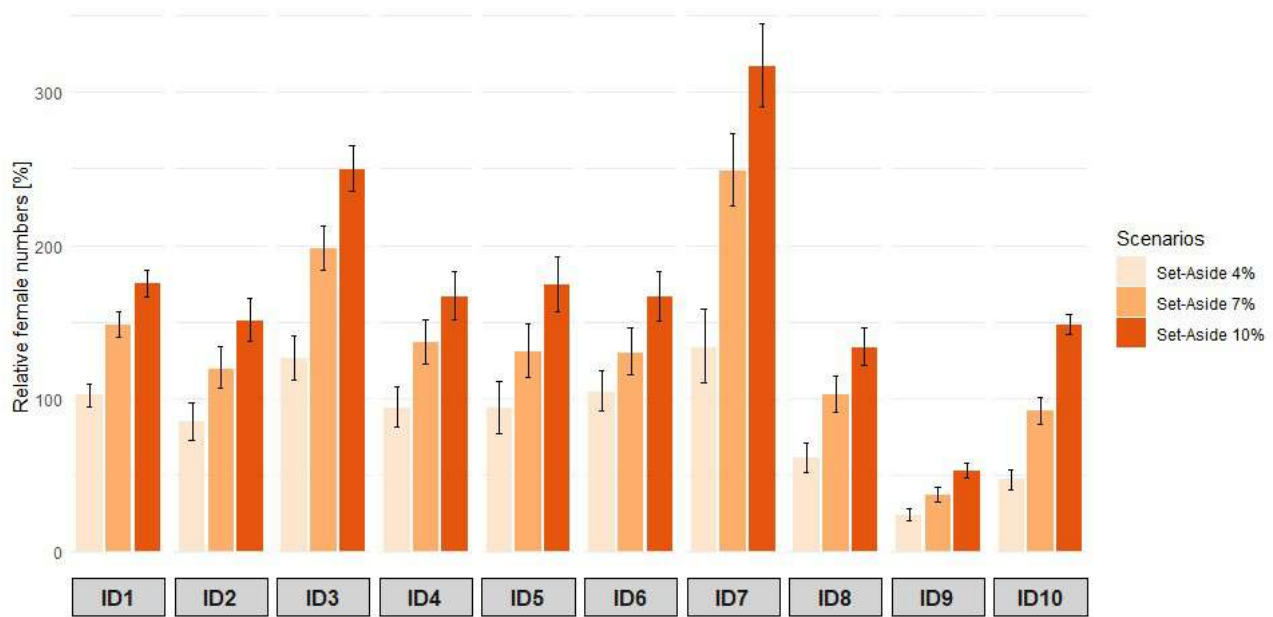


Figure 9.55 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

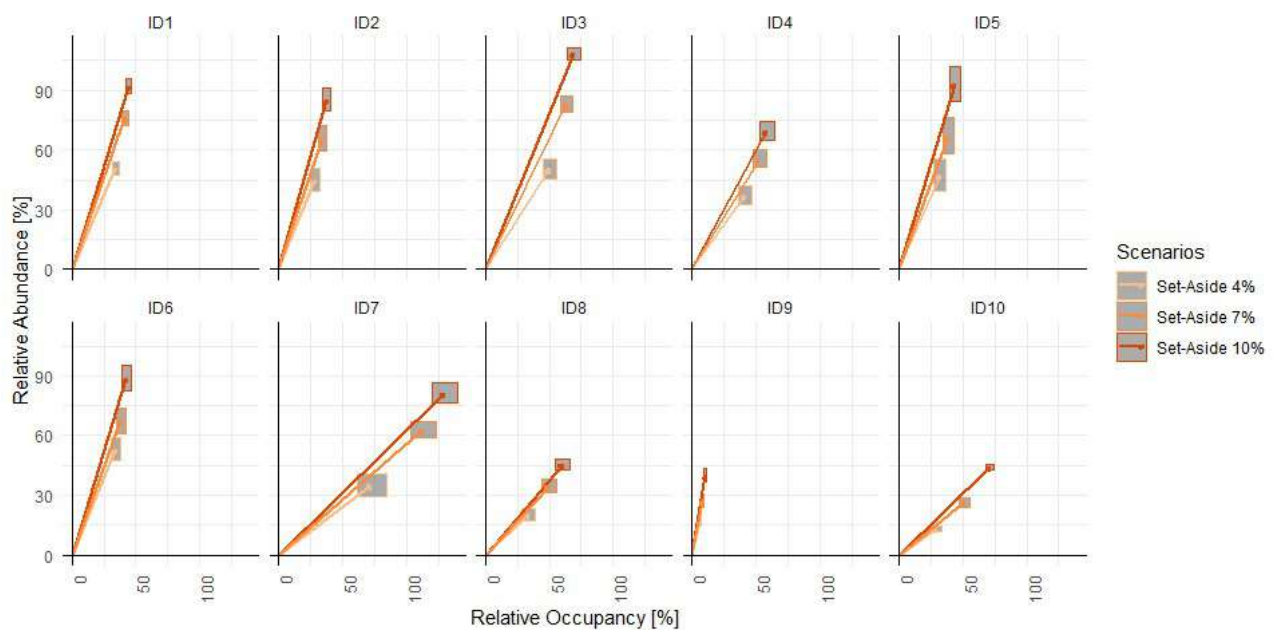


Figure 9.56 Setaside scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4.6 Legume

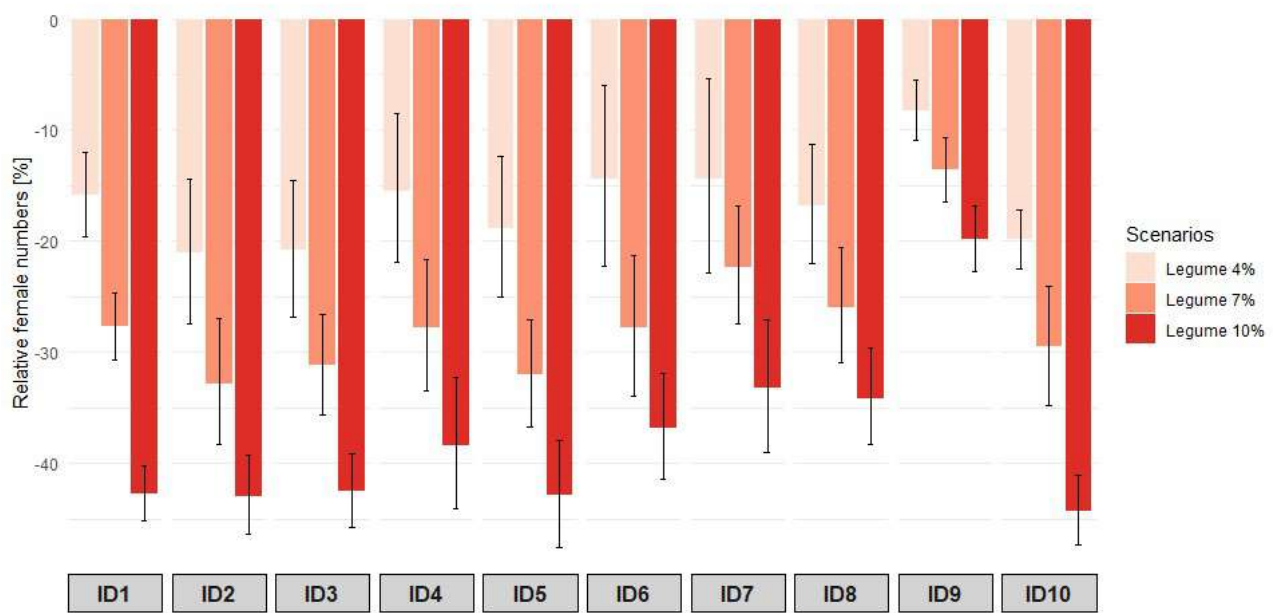


Figure 9.57 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

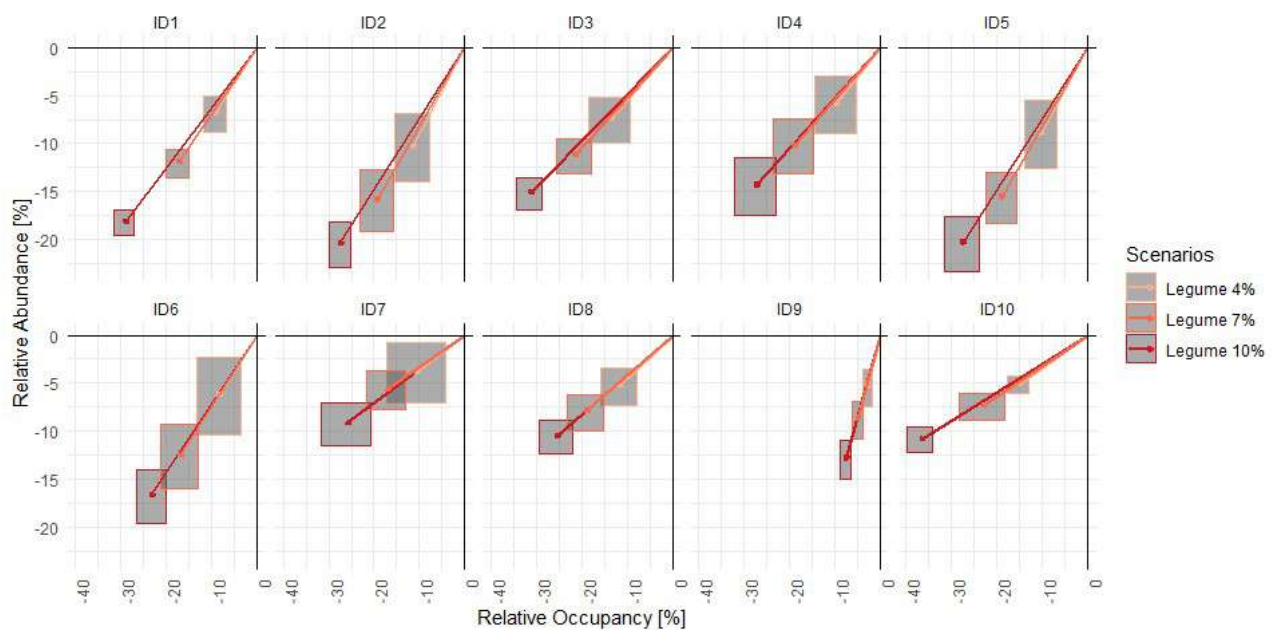


Figure 9.58 Legume scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.4.7 Biopesticides

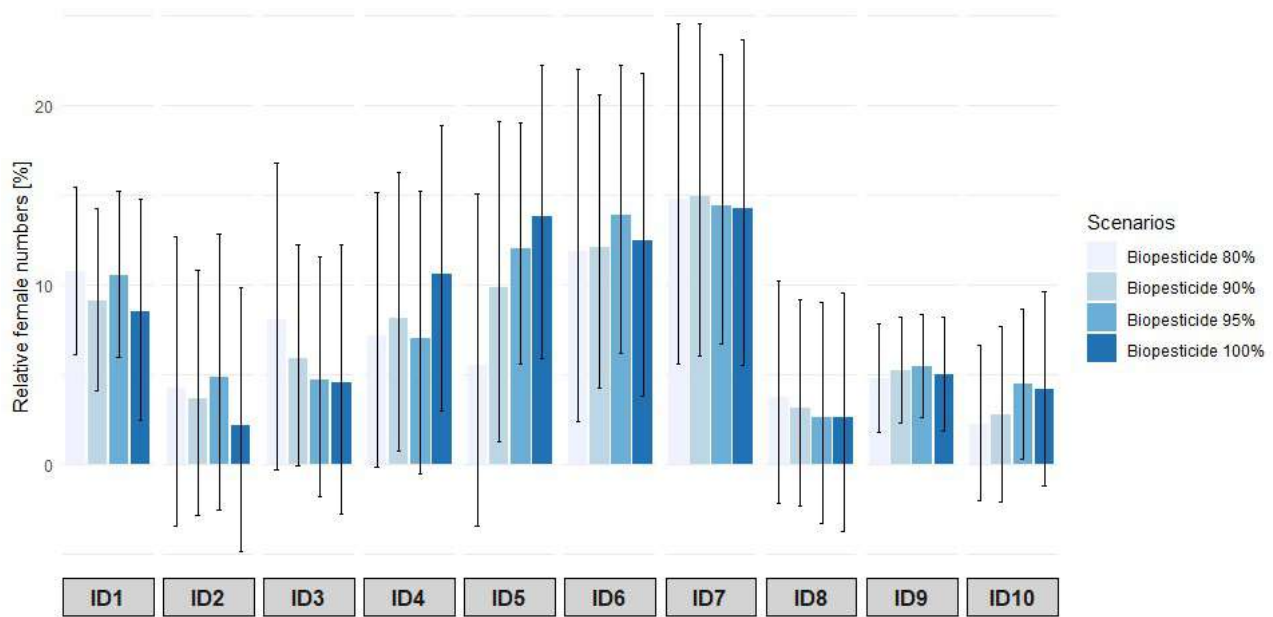


Figure 9.59 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Poland.

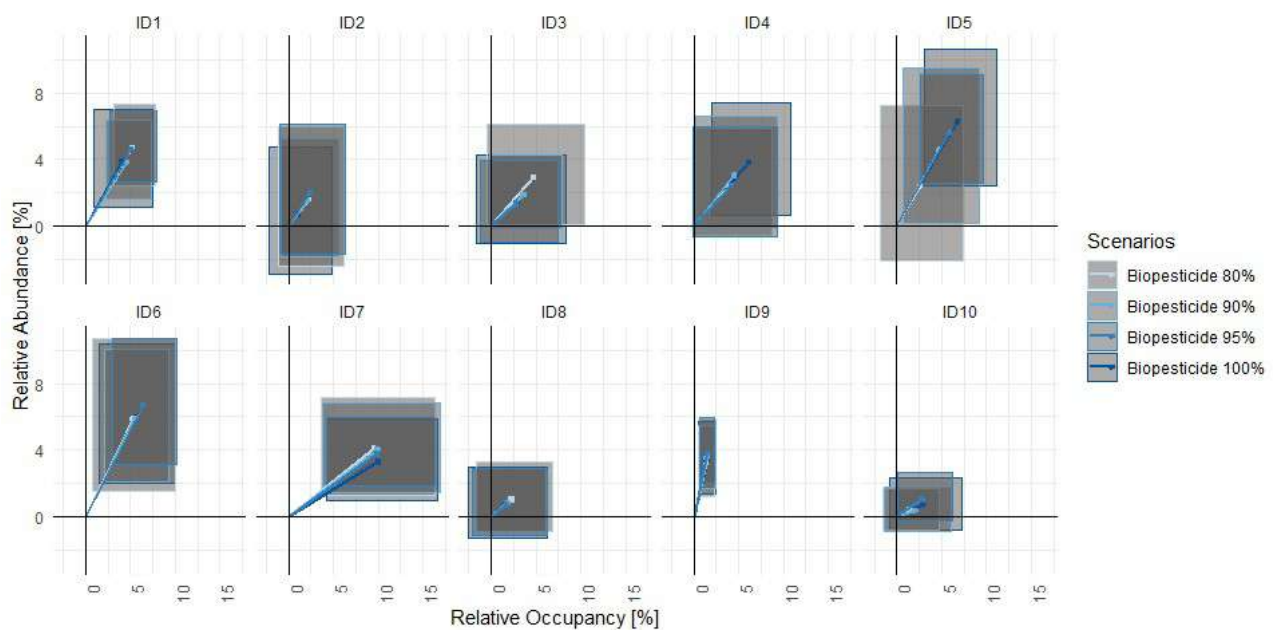


Figure 9.60 Biopesticide scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Poland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5 Finland

9.5.1 Flower field margins

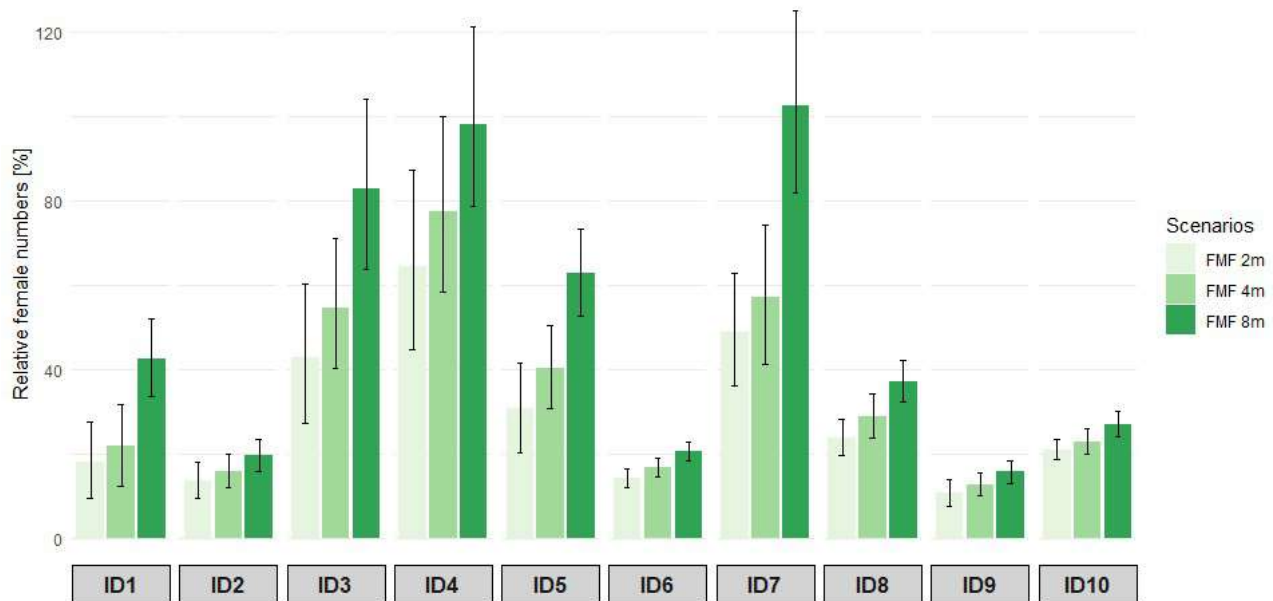


Figure 9.61 Flower field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

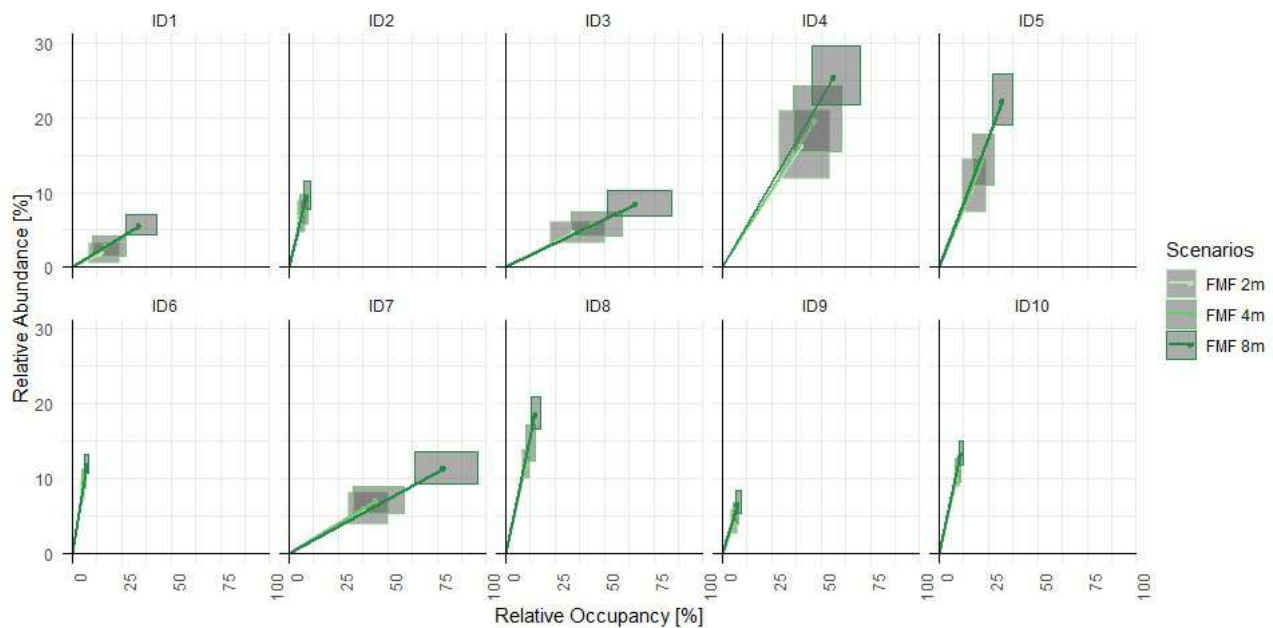


Figure 9.62 Flower field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5.2 Grassy field margins

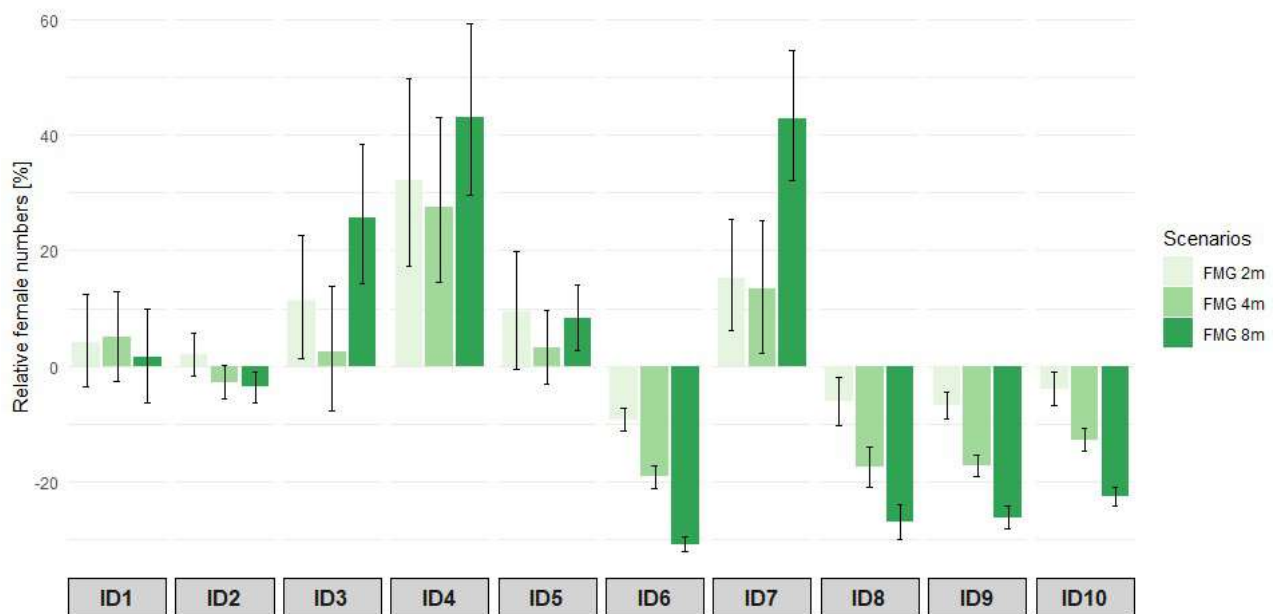


Figure 9.63 Grassy field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

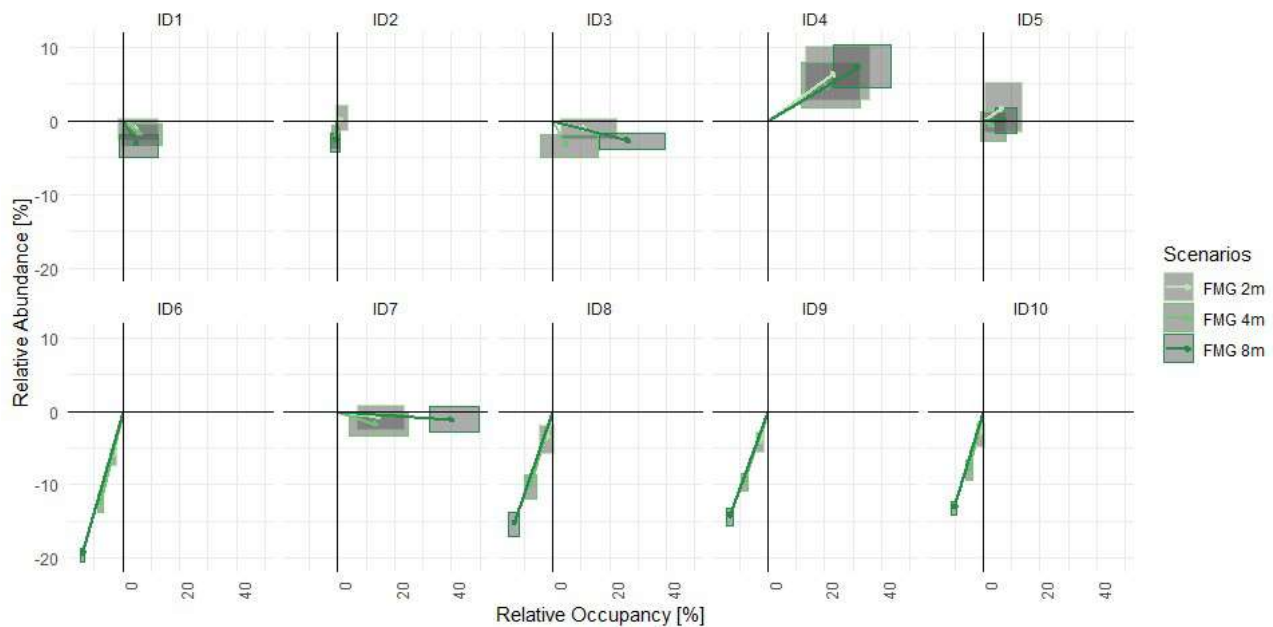


Figure 9.64 Grassy field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5.3 Mixed field margins

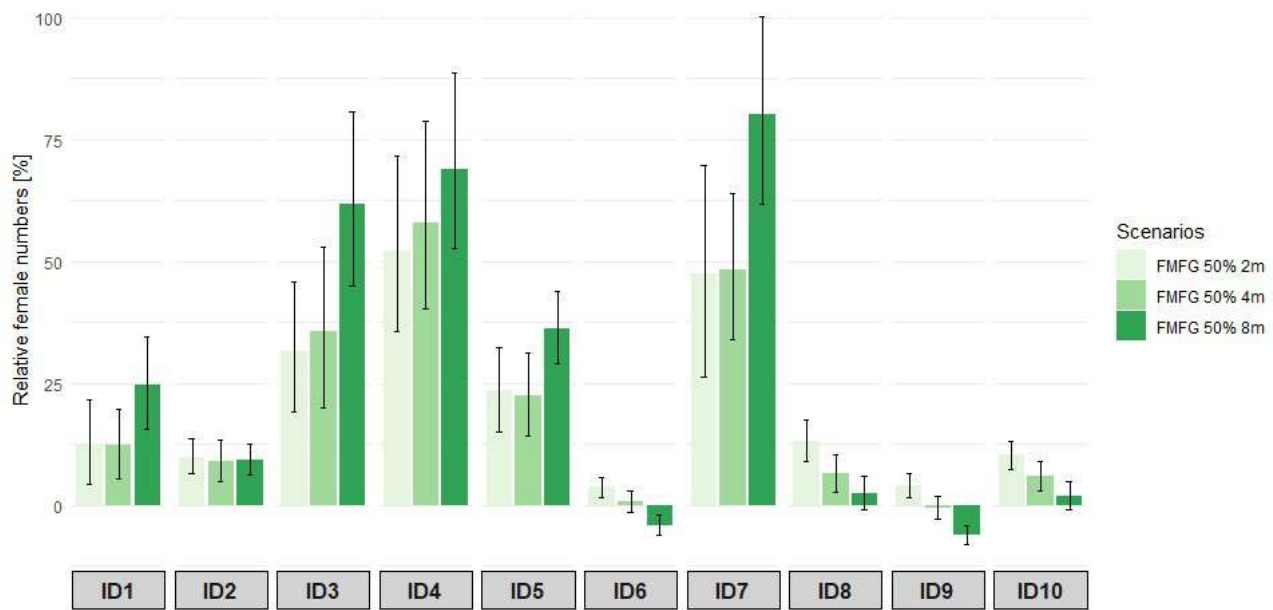


Figure 9.65 Mixed field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

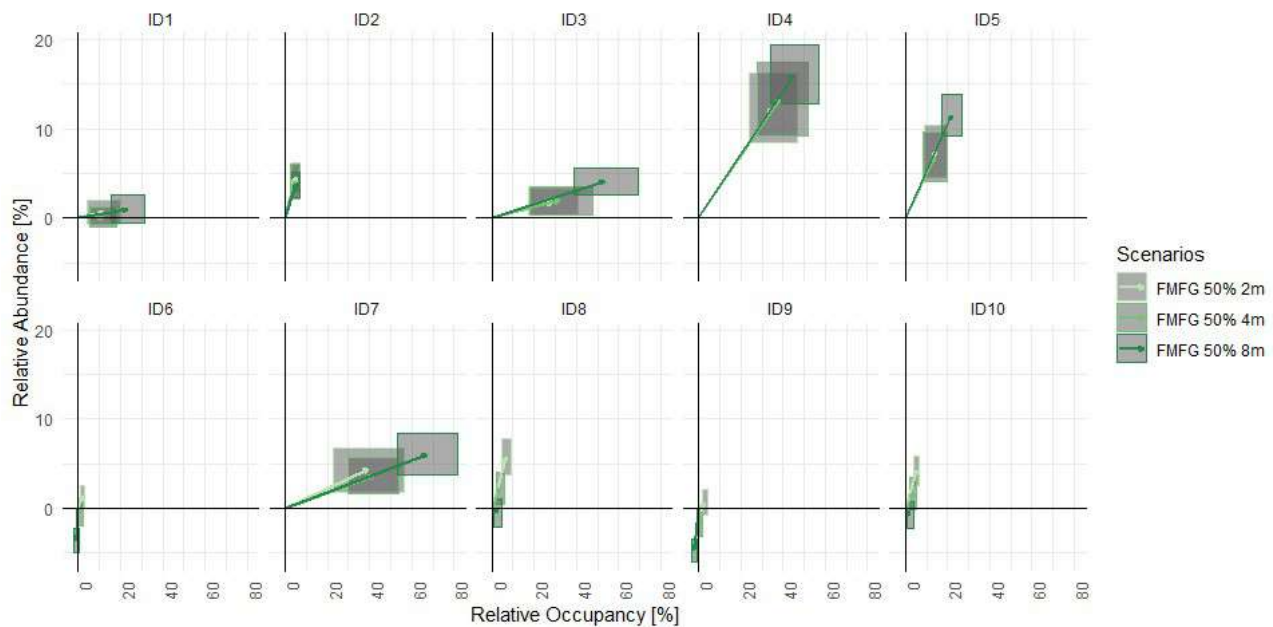


Figure 9.66 Mixed field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5.4 Flower, grassy and mixed field margins

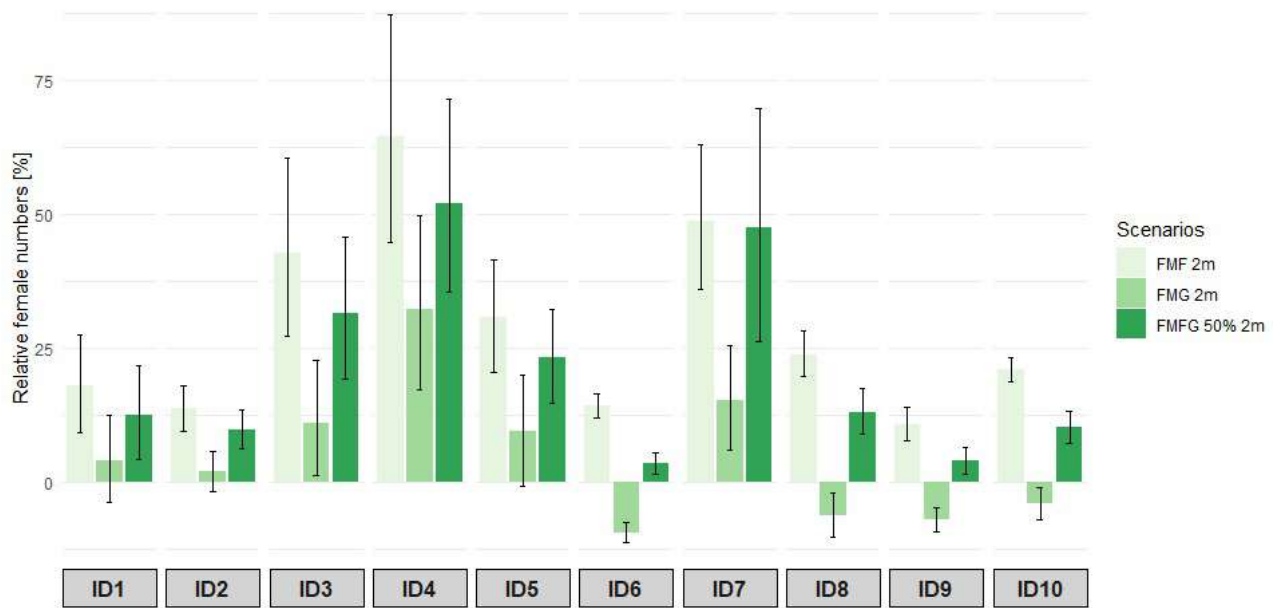


Figure 9.67 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

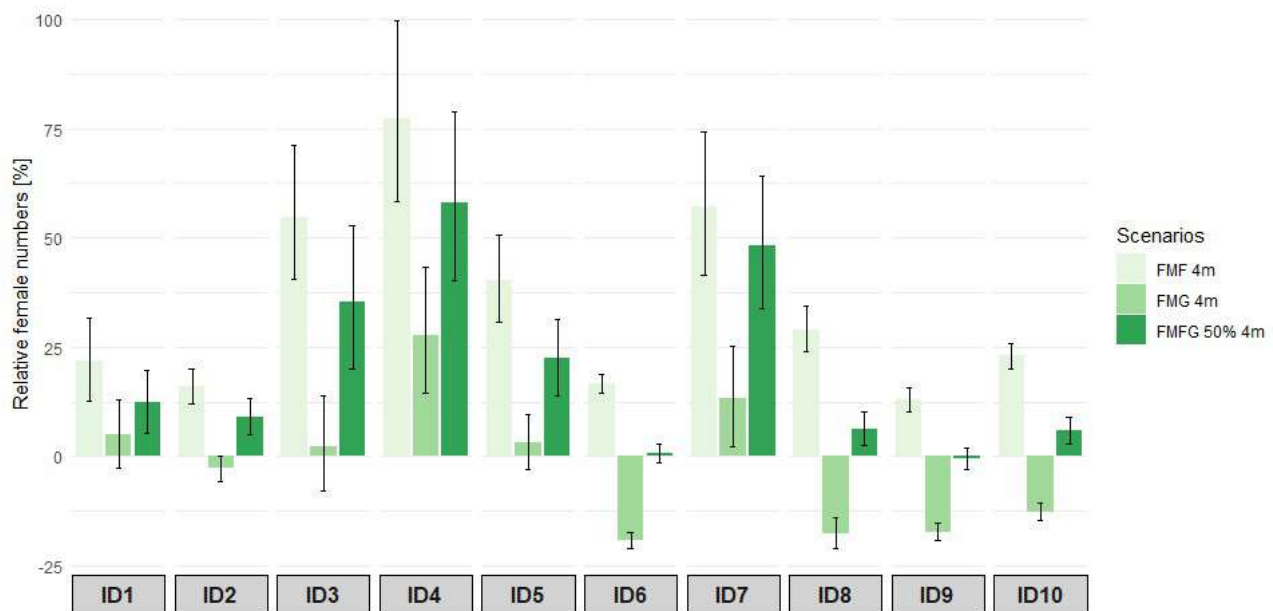


Figure 9.68 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

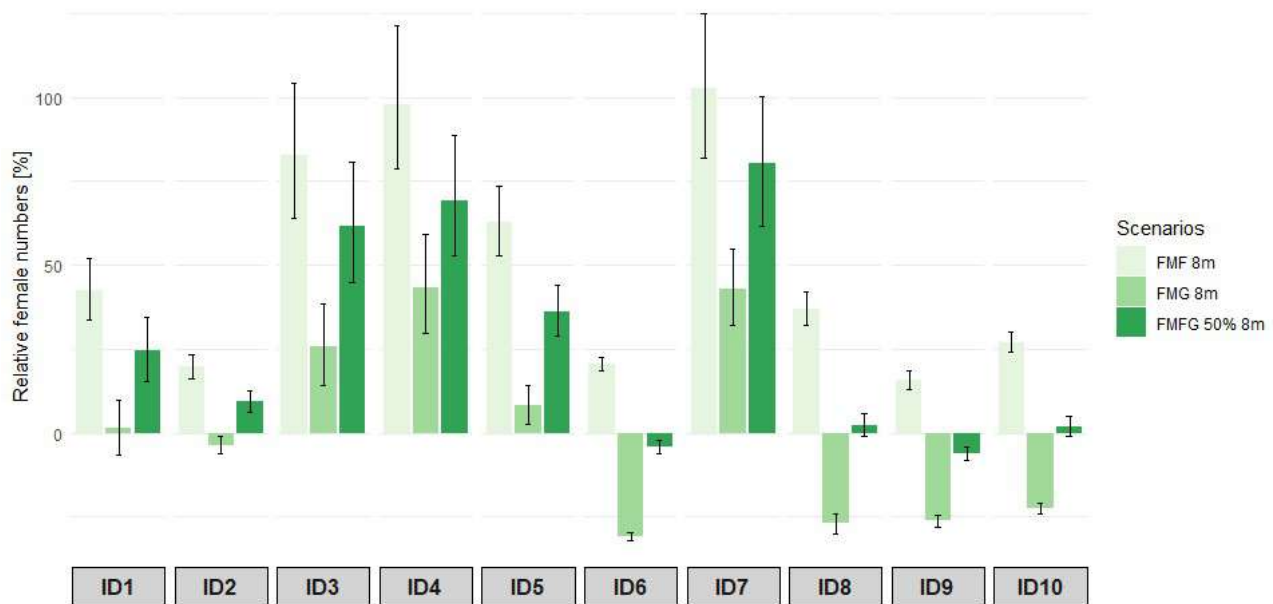


Figure 9.69 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

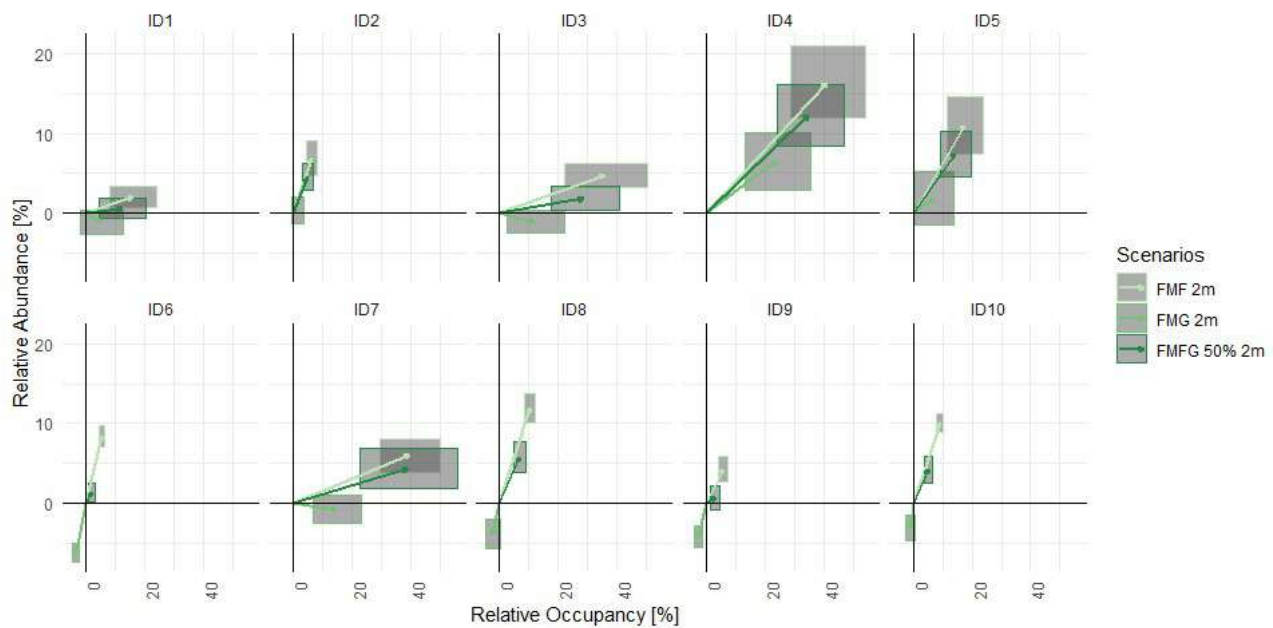


Figure 9.70 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

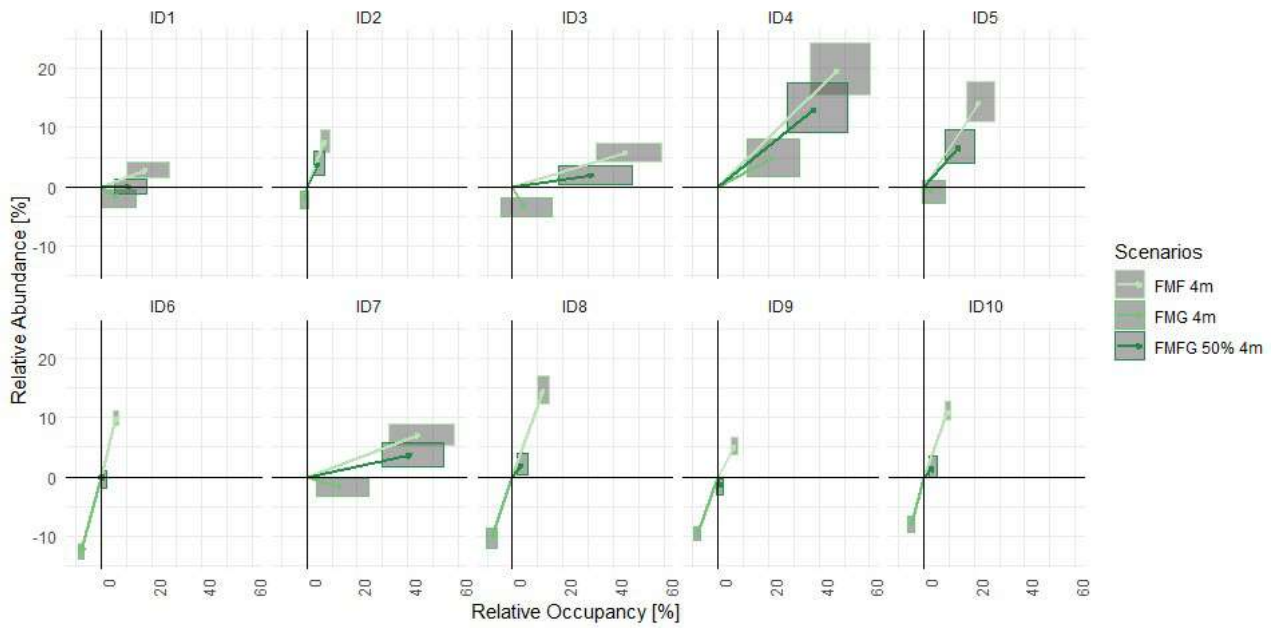


Figure 9.71 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes..

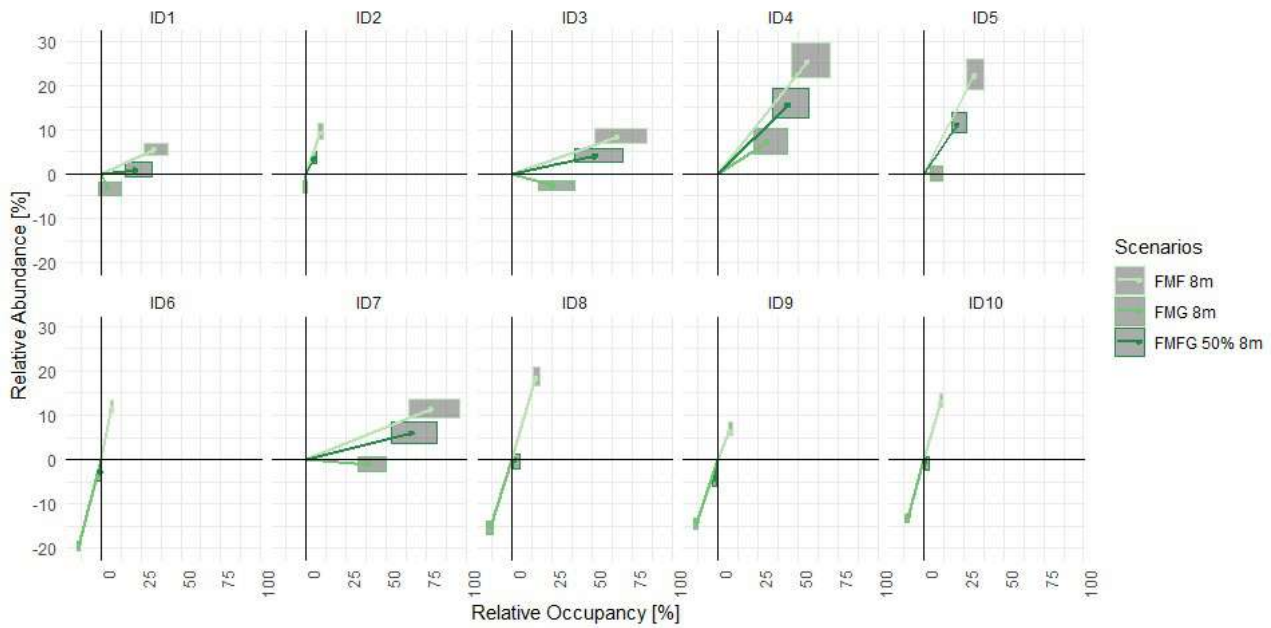


Figure 9.72 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5.5 Setaside

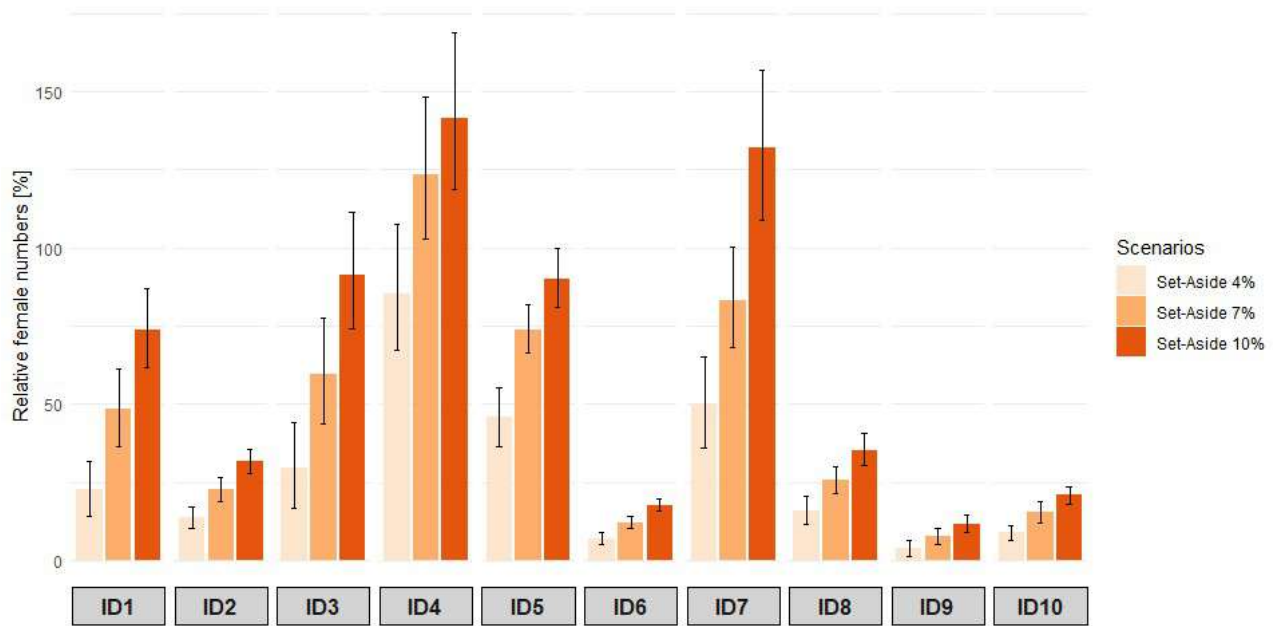


Figure 9.73 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

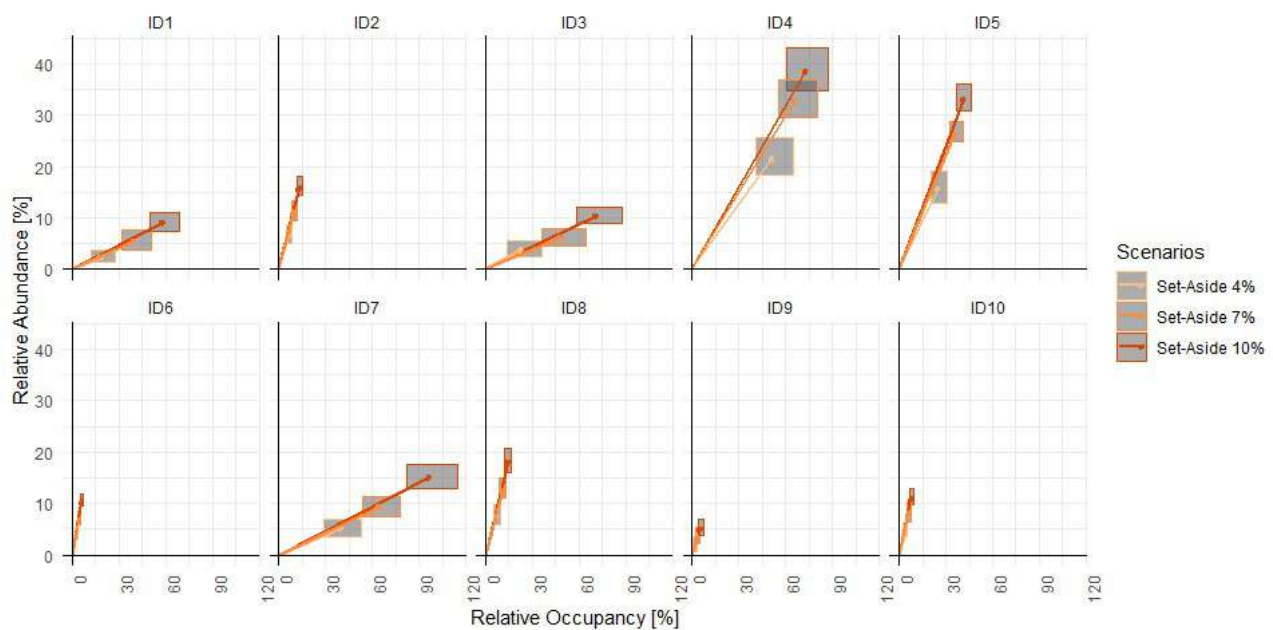


Figure 9.74 Setaside scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5.6 Legume

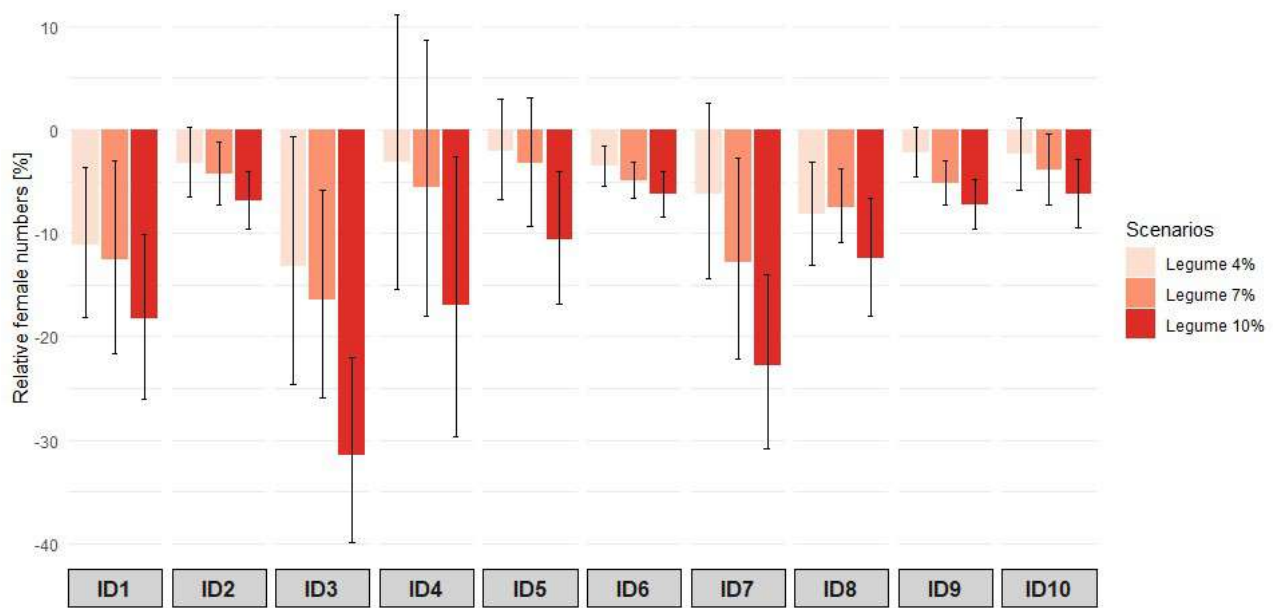


Figure 9.75 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

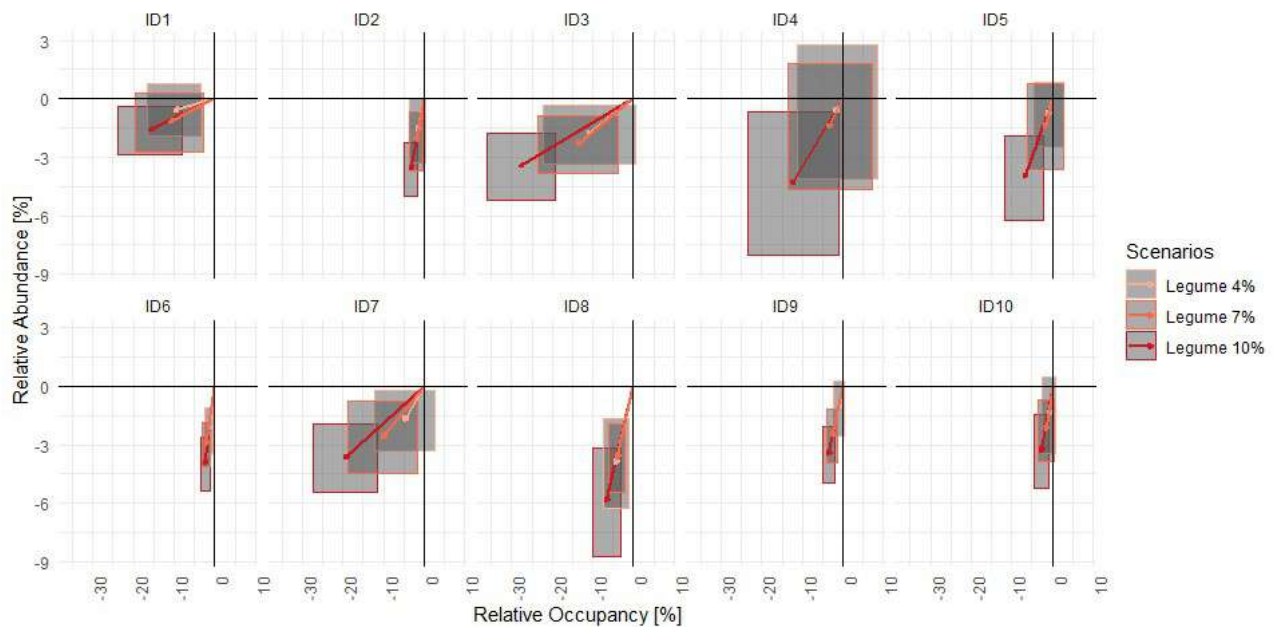


Figure 9.76 Legume scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.5.7 Biopesticides

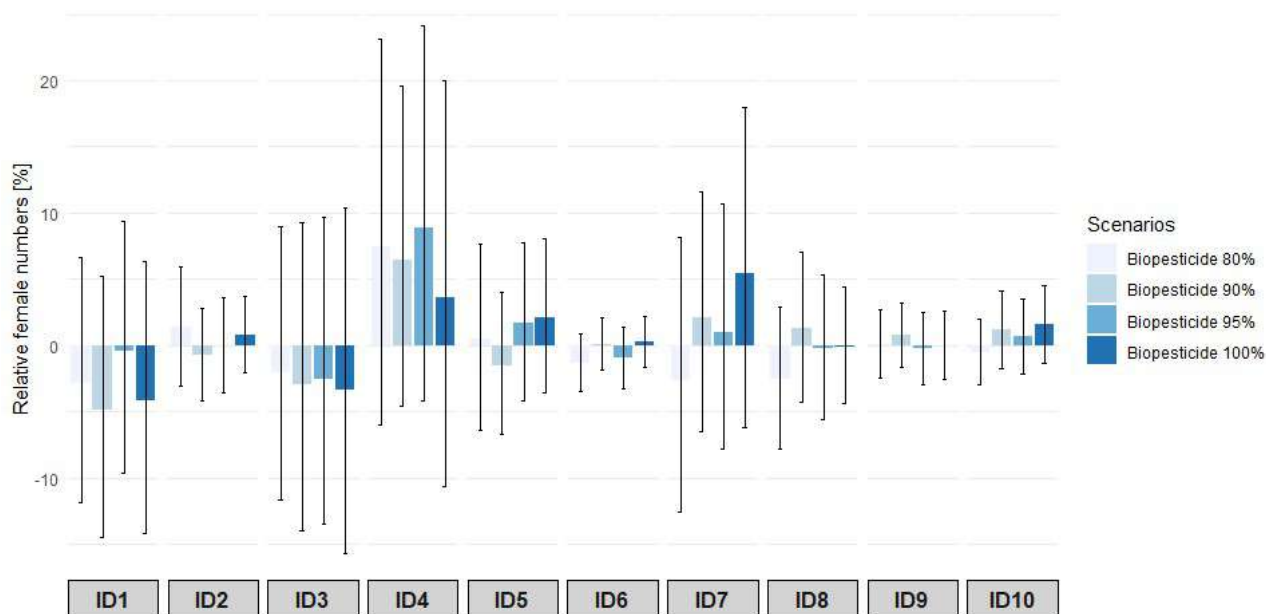


Figure 9.77 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in Finland.

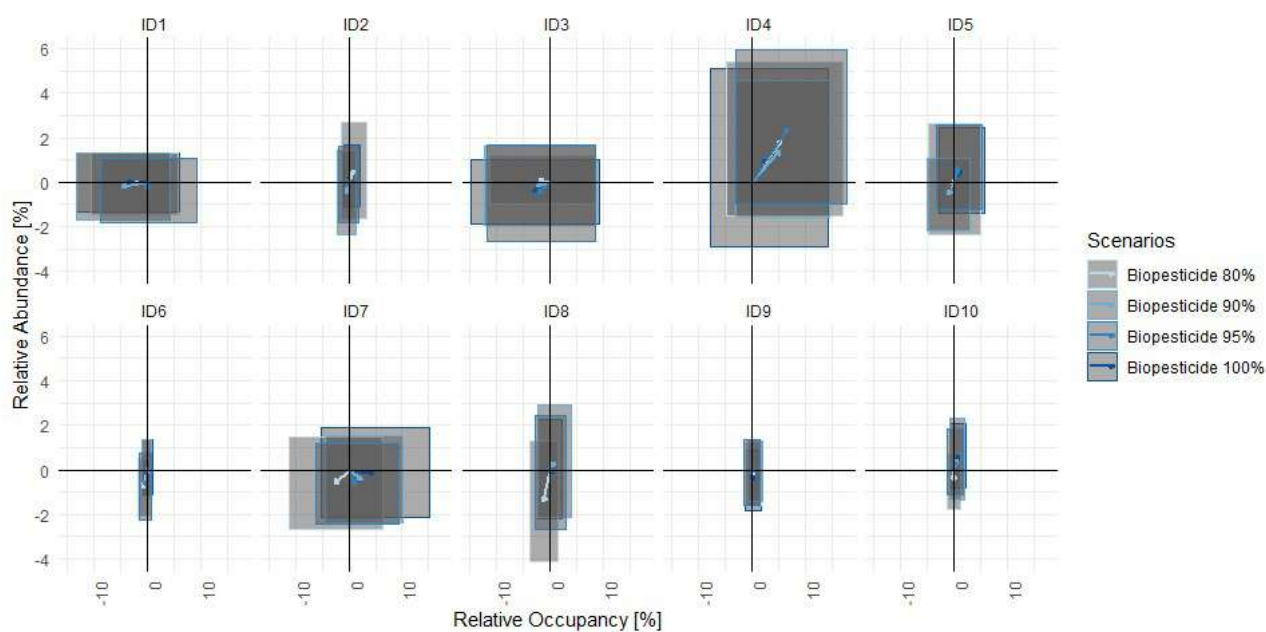


Figure 9.78 Biopesticide scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in Finland at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6 France

9.6.1 Flower field margins

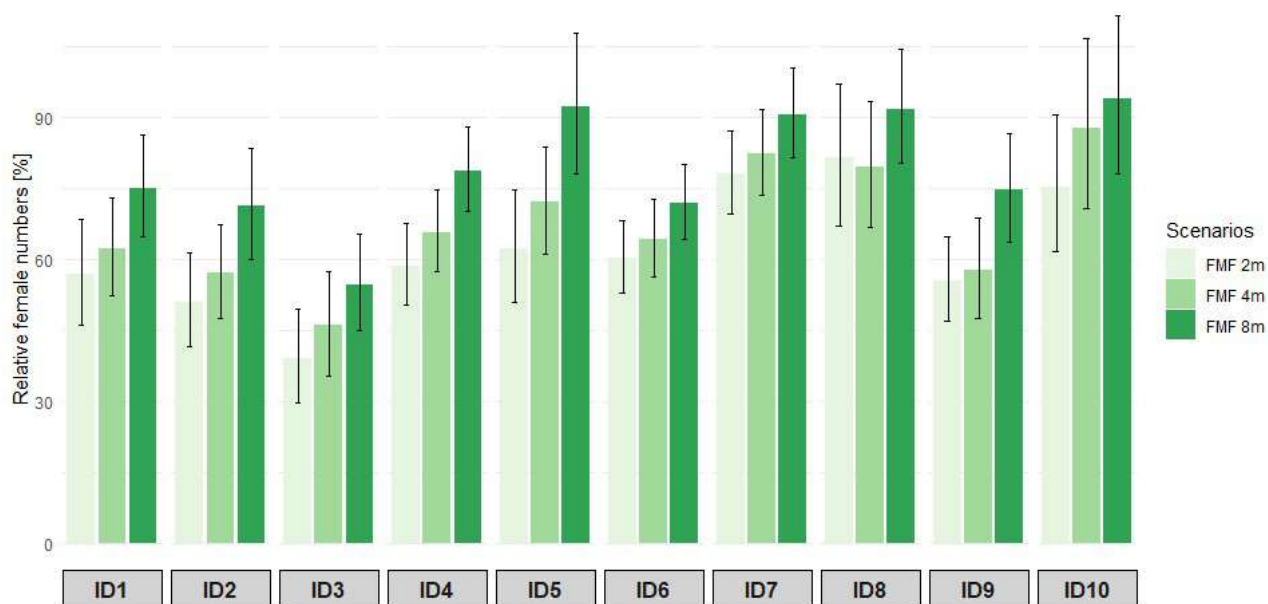


Figure 9.79 Flower field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

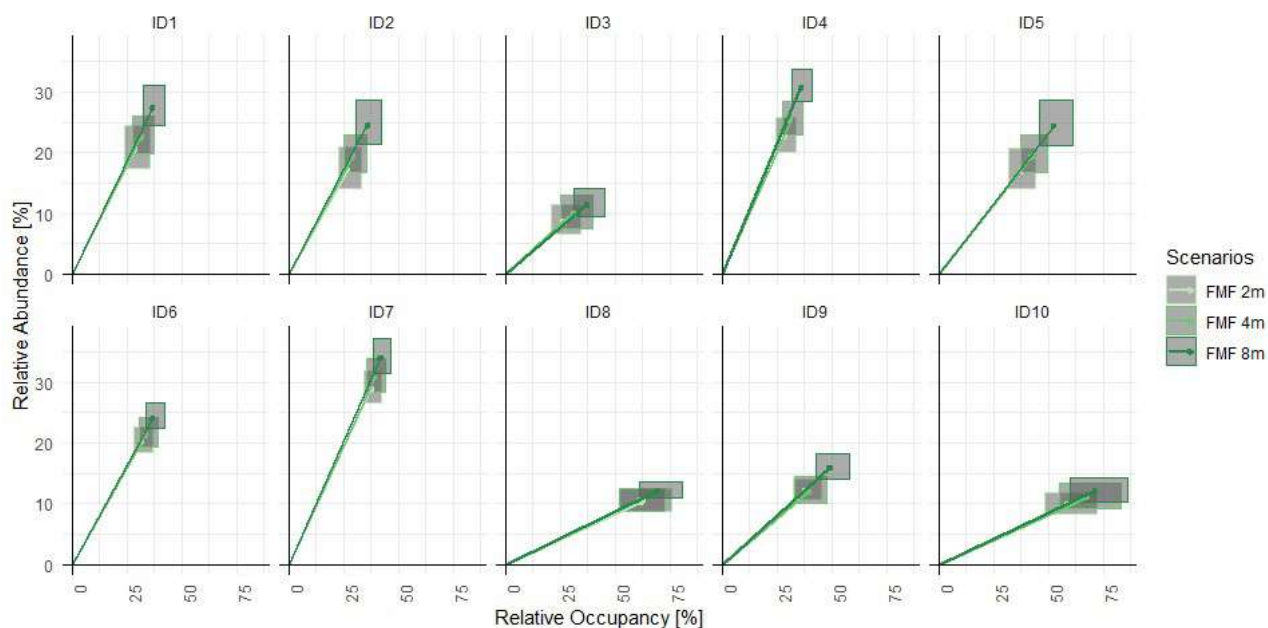


Figure 9.80 Flower field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6.2 Grassy field margins

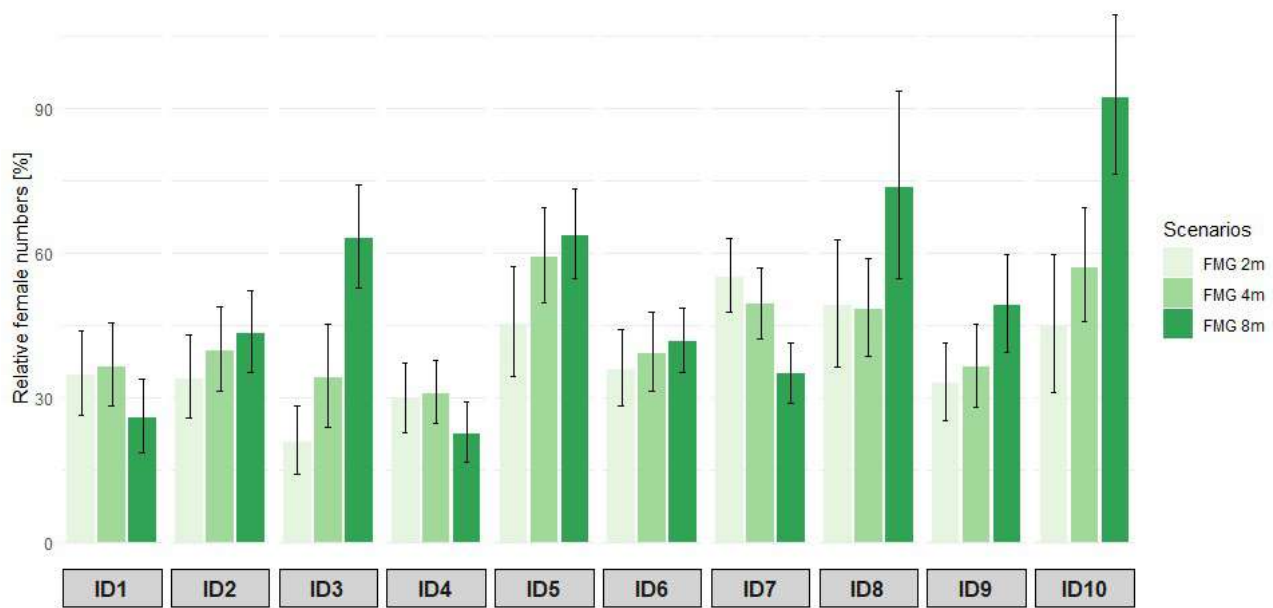


Figure 9.81 Grassy field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

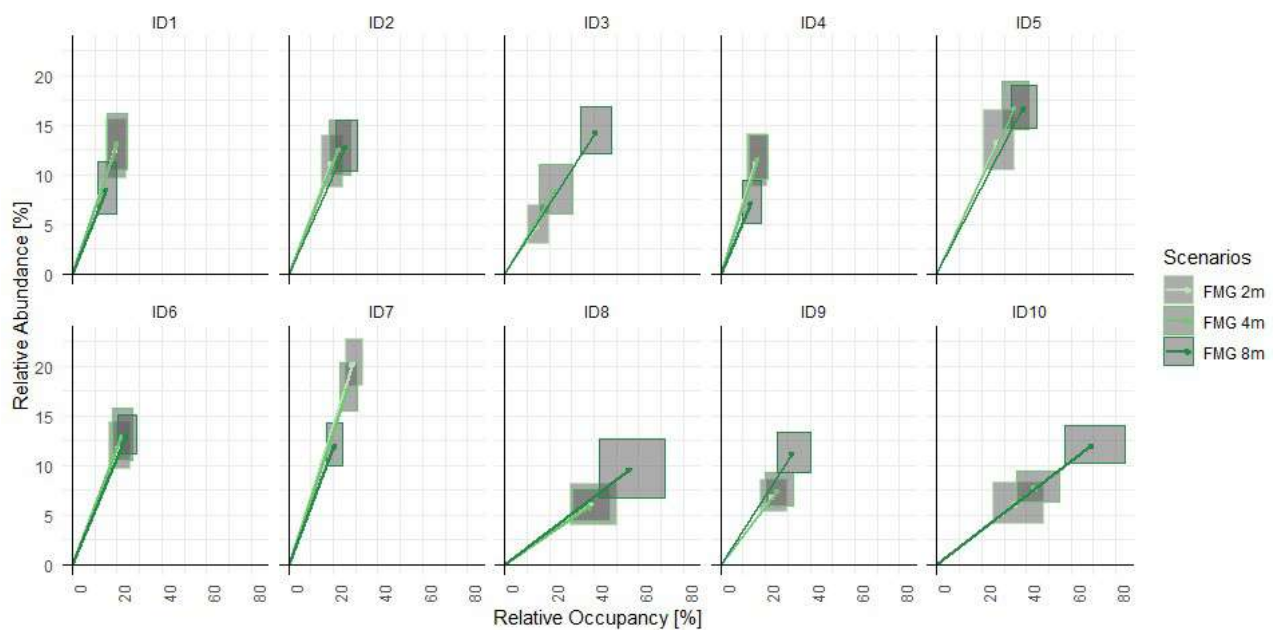


Figure 9.82 Grassy field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6.3 Mixed field margins

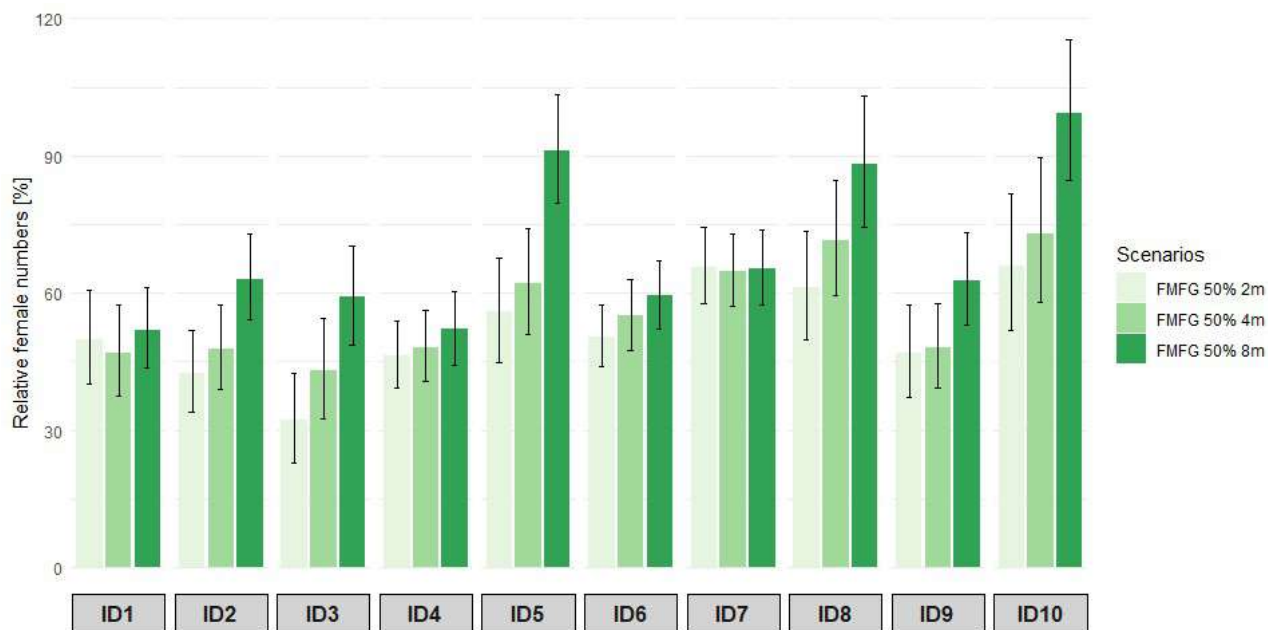


Figure 9.83 Mixed field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

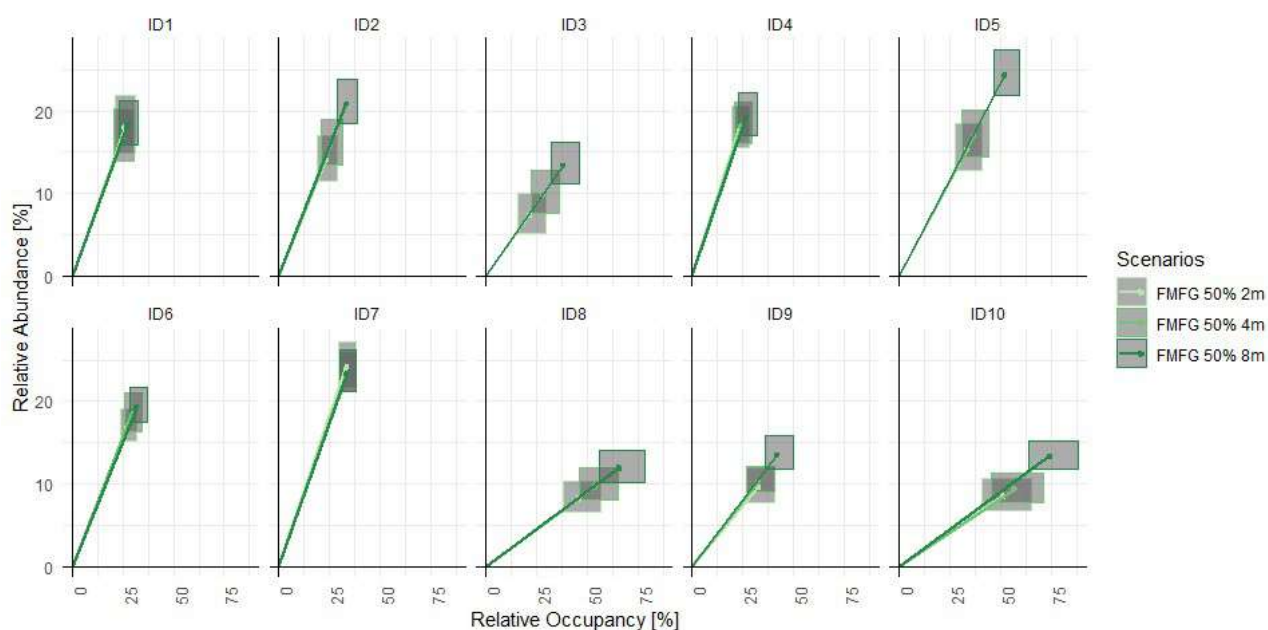


Figure 9.84 Mixed field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6.4 Flower, grassy and mixed field margins

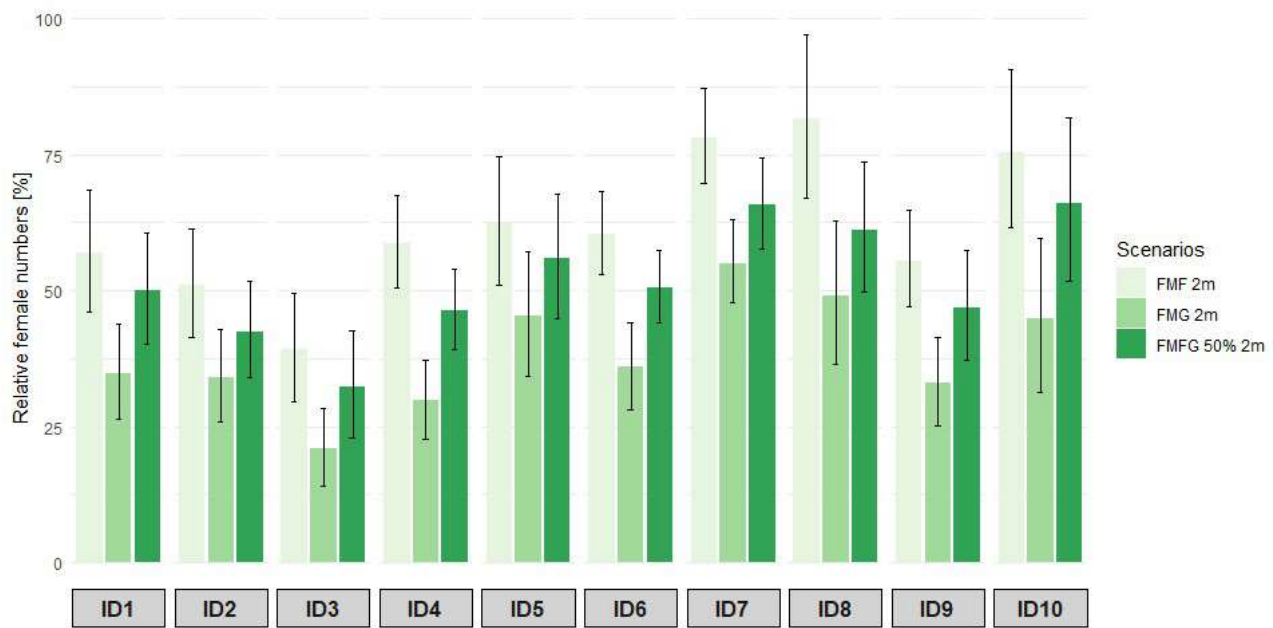


Figure 9.85 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

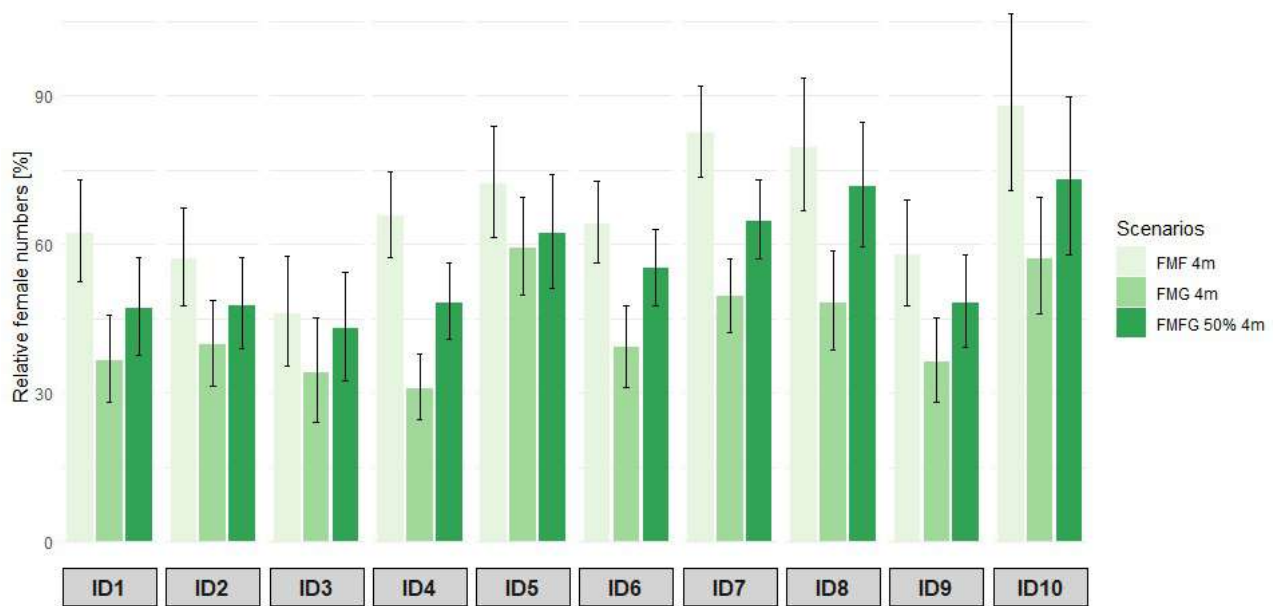


Figure 9.86 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

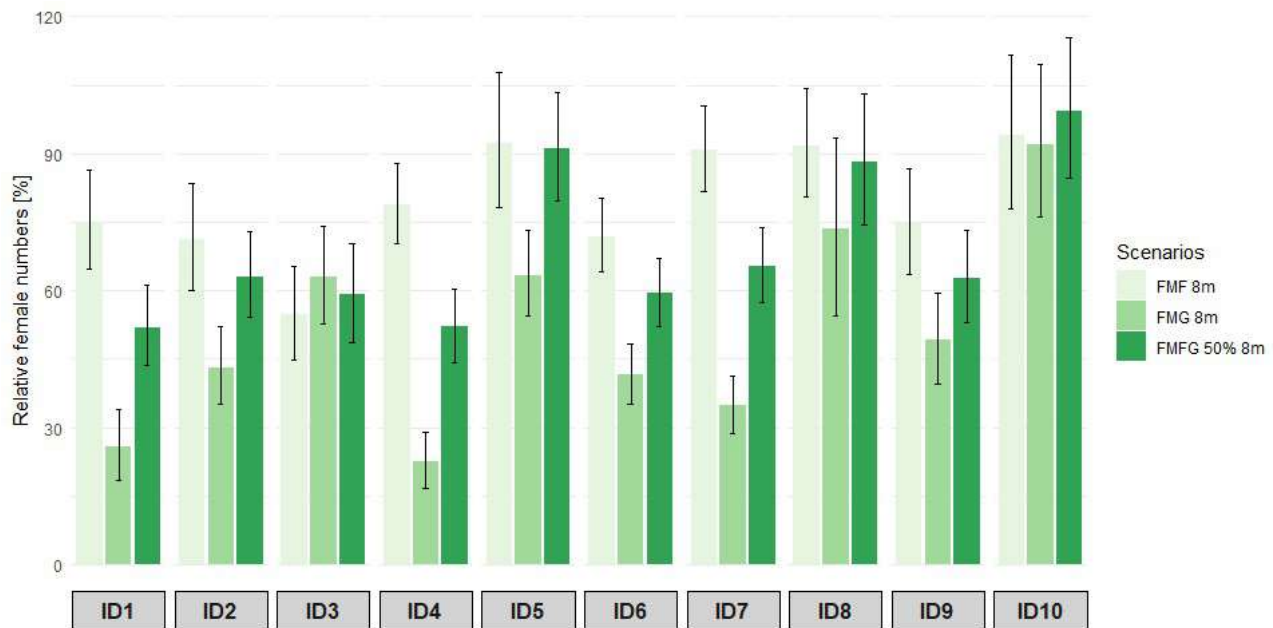


Figure 9.87 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

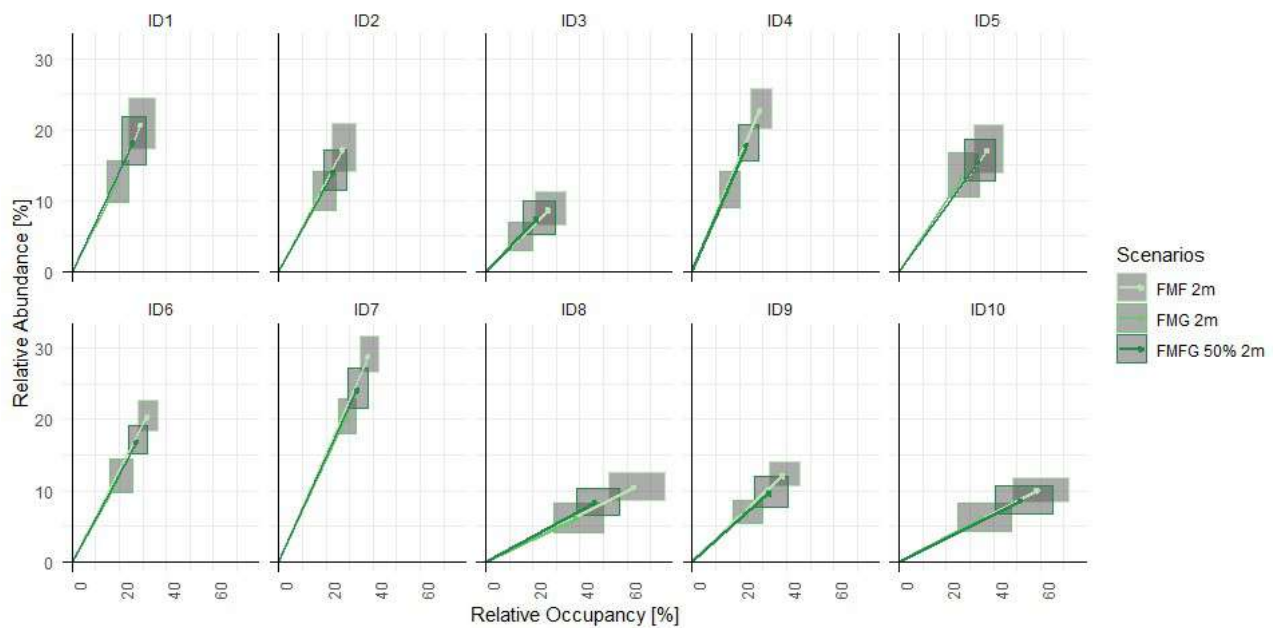


Figure 9.88 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

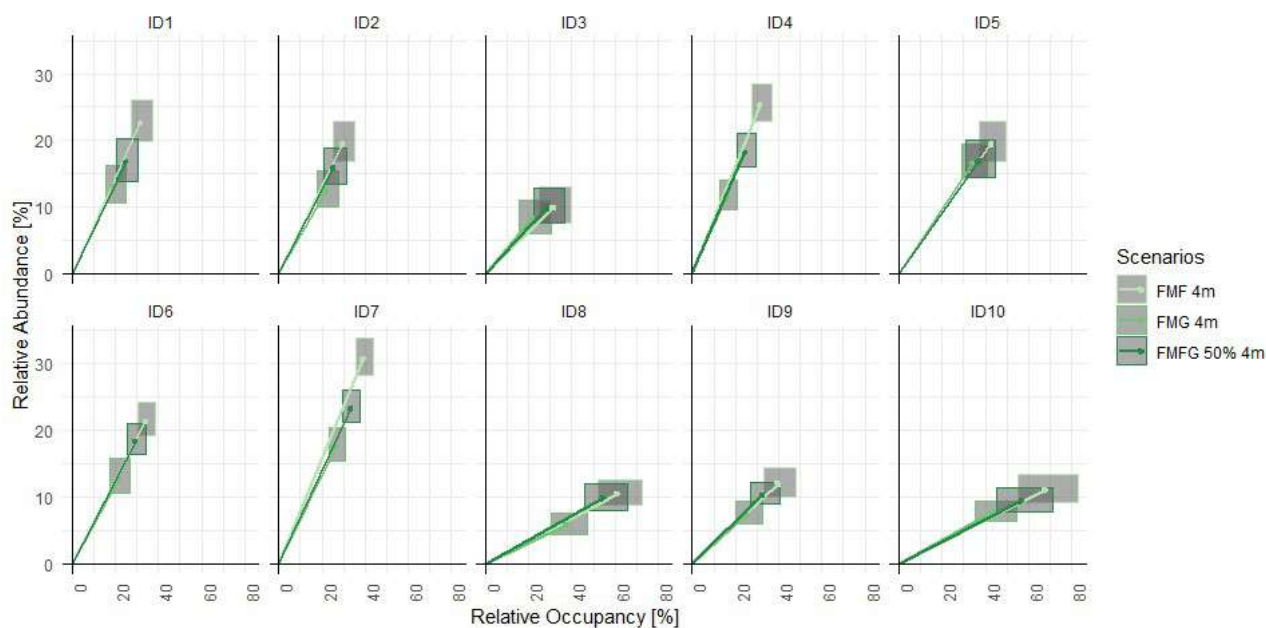


Figure 9.89 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes..

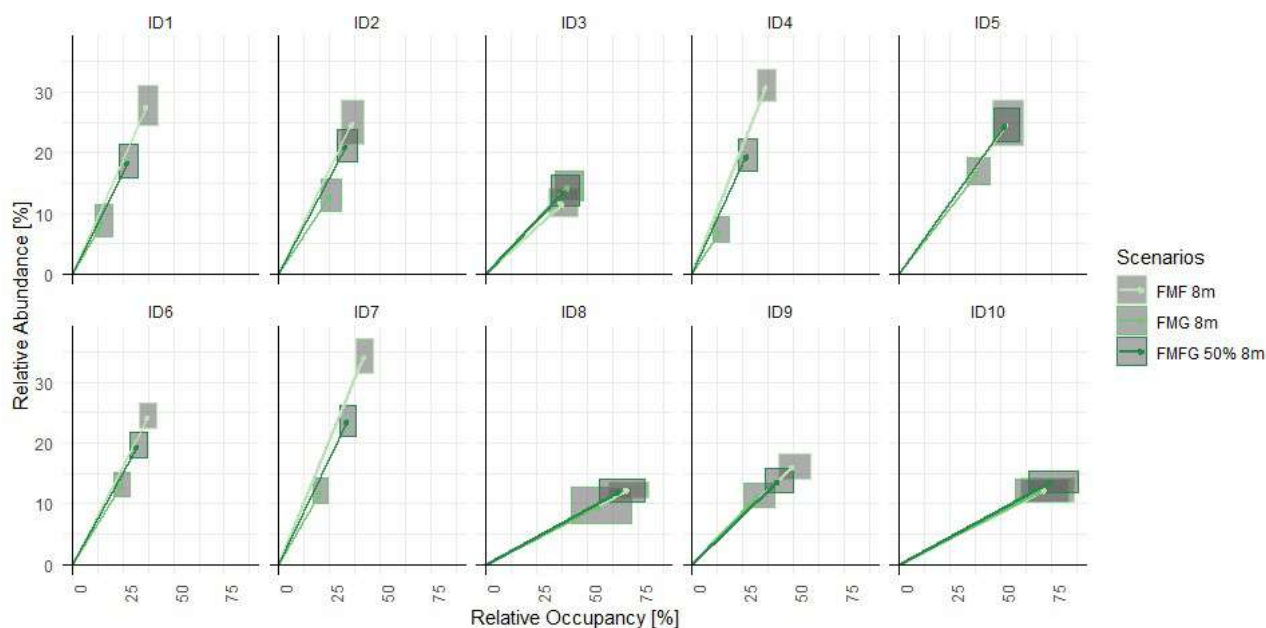


Figure 9.90 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6.5 Setaside

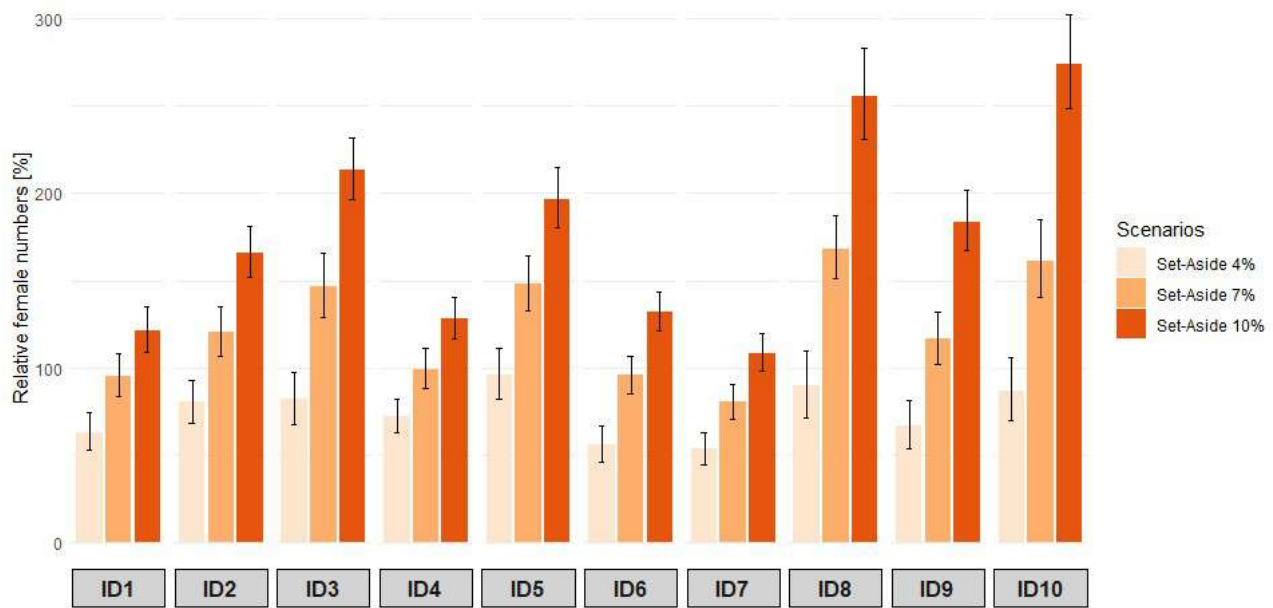


Figure 9.91 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

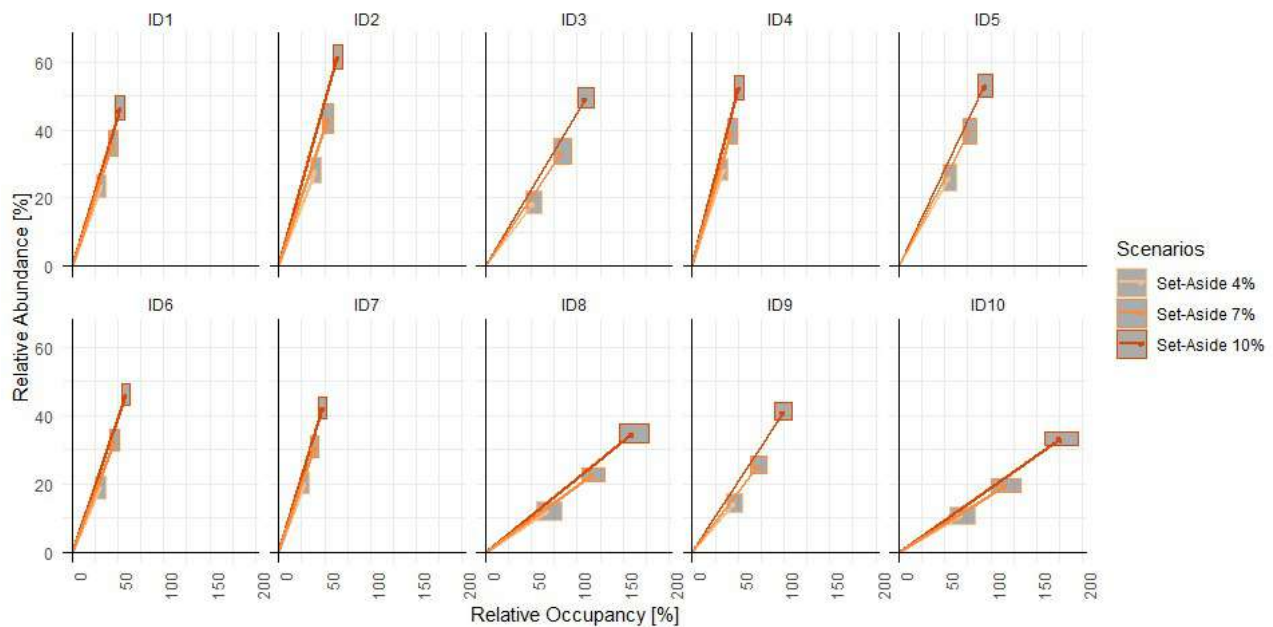


Figure 9.92 Setaside scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6.6 Legume

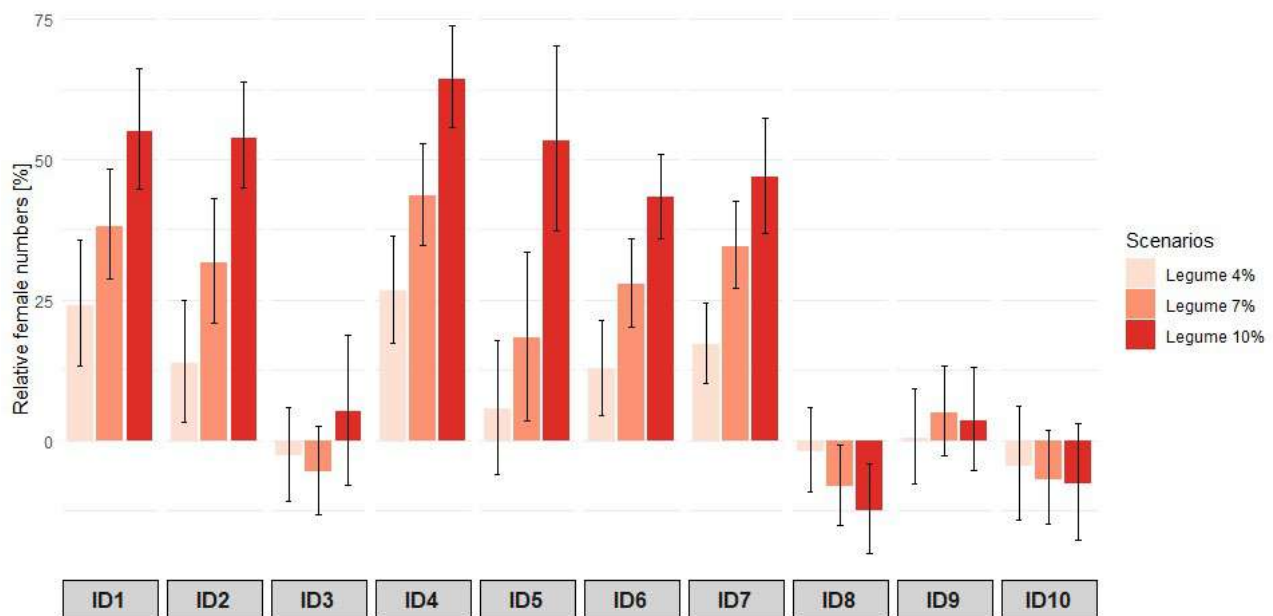


Figure 9.93 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

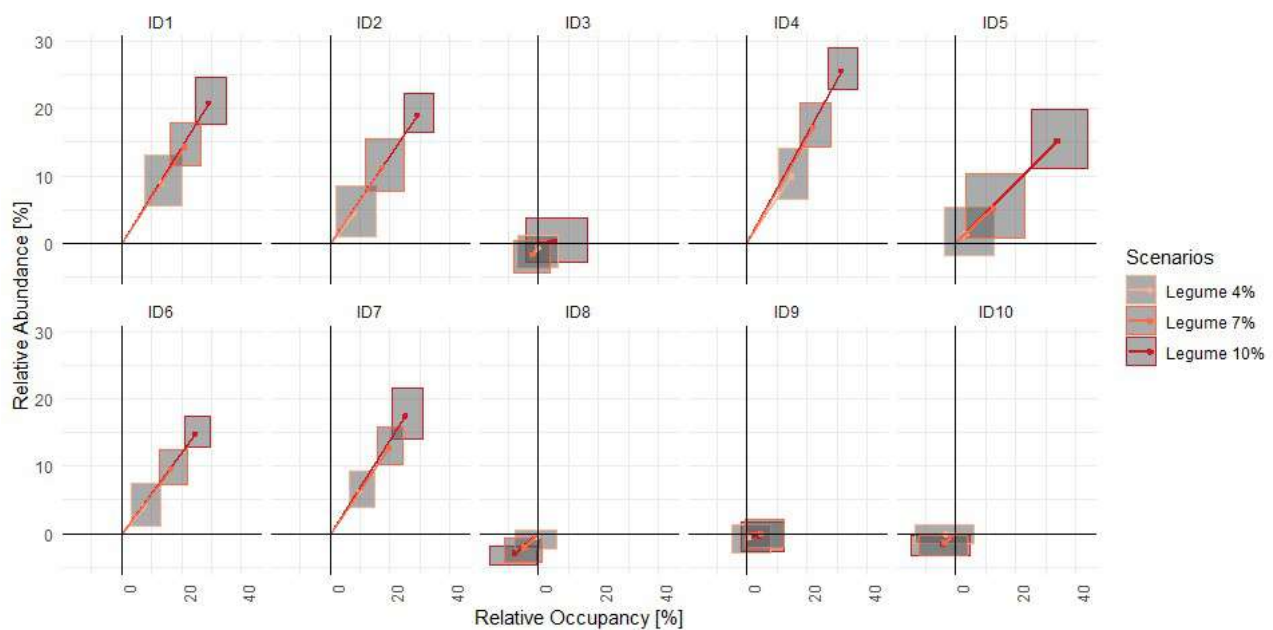


Figure 9.94 Legume scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.6.7 Biopesticides

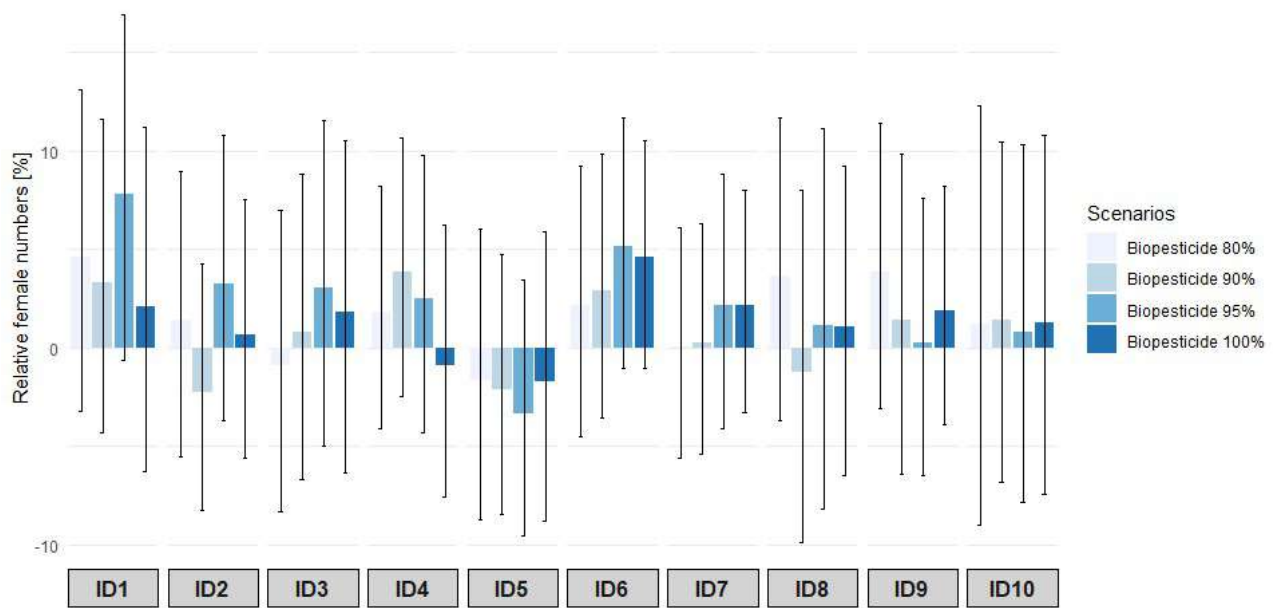


Figure 9.95 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in France.

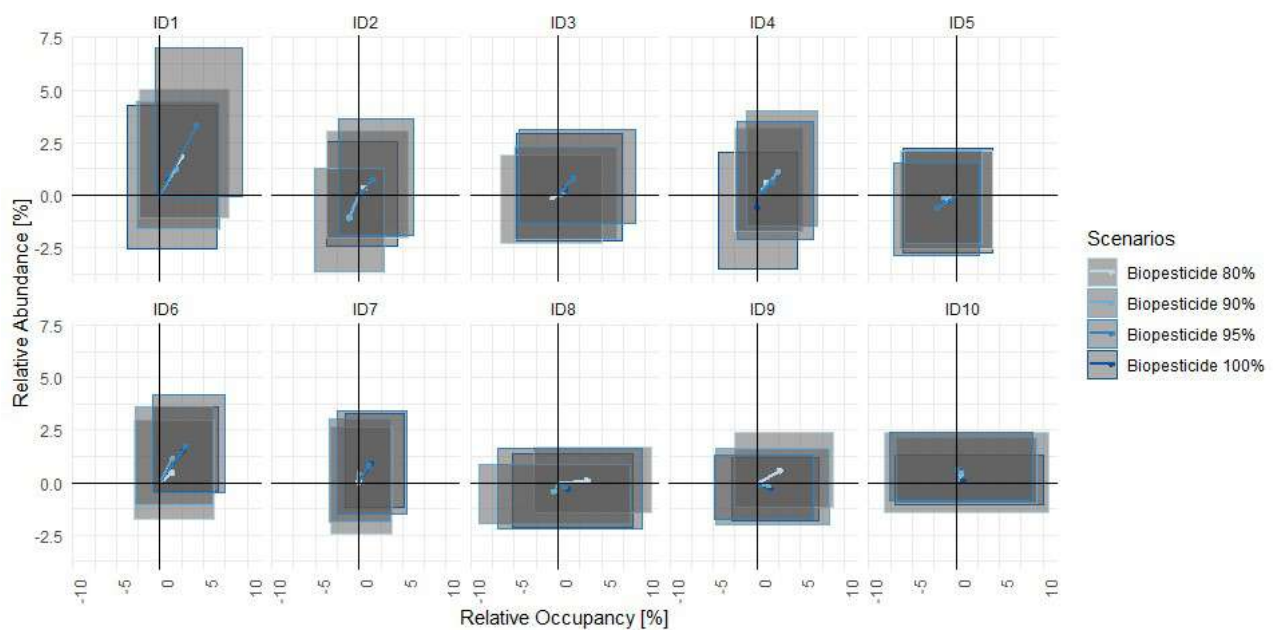


Figure 9.96 Biopesticide scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in France at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7 Netherlands

9.7.1 Flower field margins

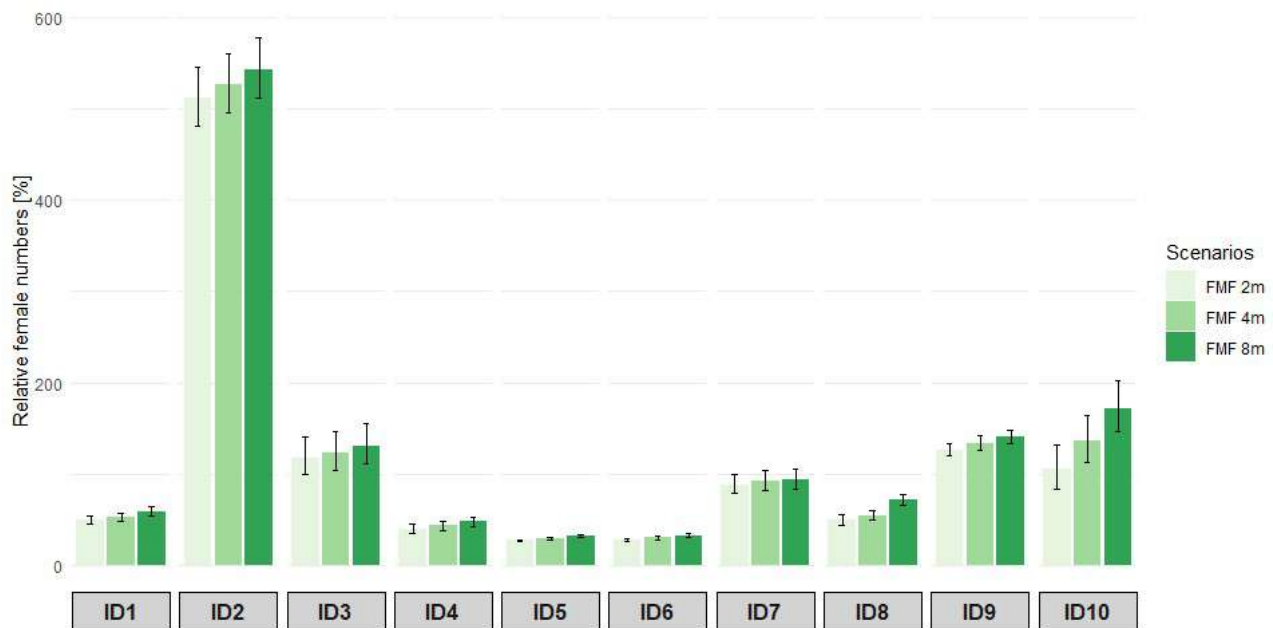


Figure 9.97 Flower field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

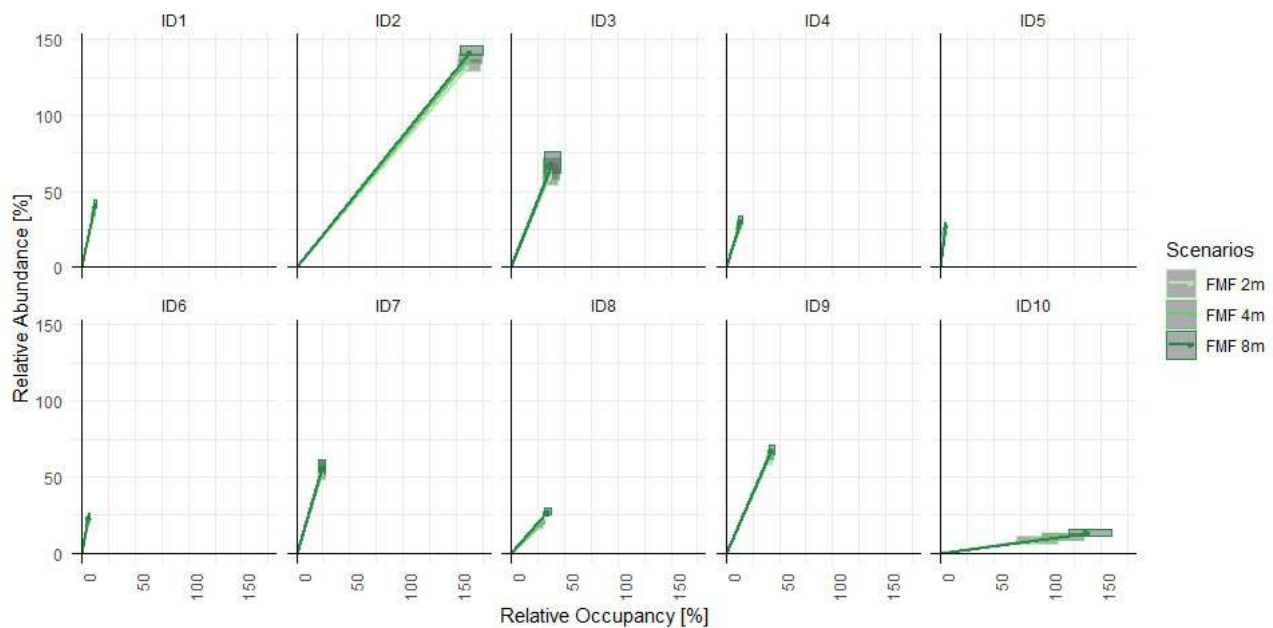


Figure 9.98 Flower field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7.2 Grassy field margins

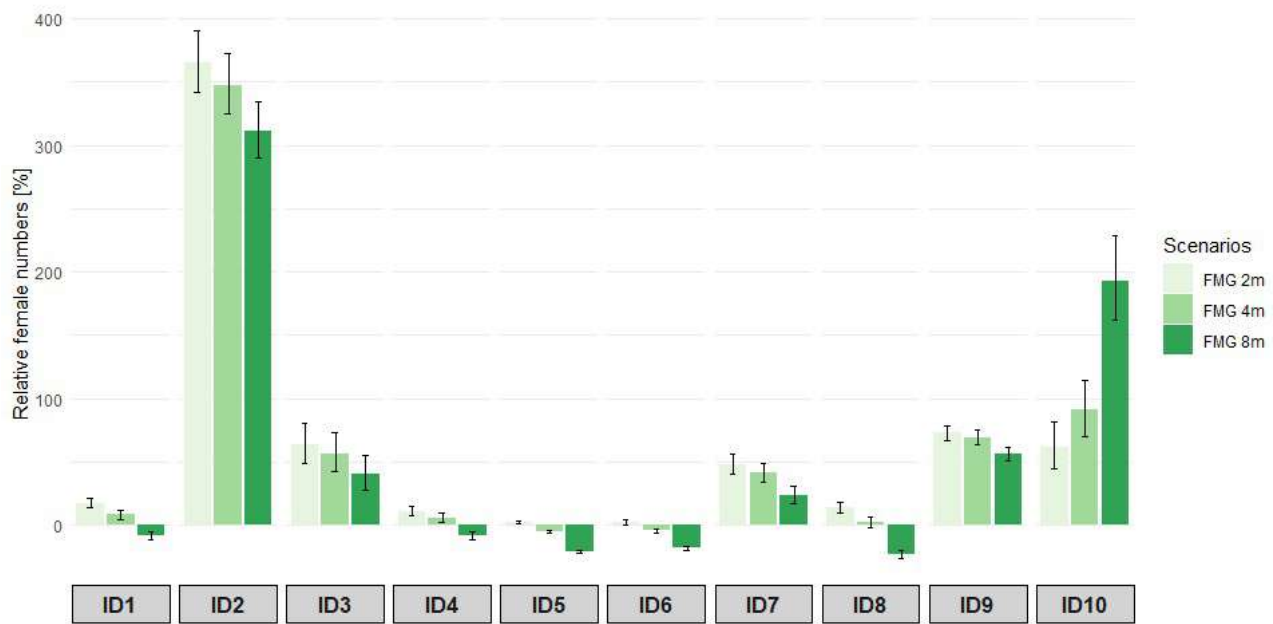


Figure 9.99 Grassy field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

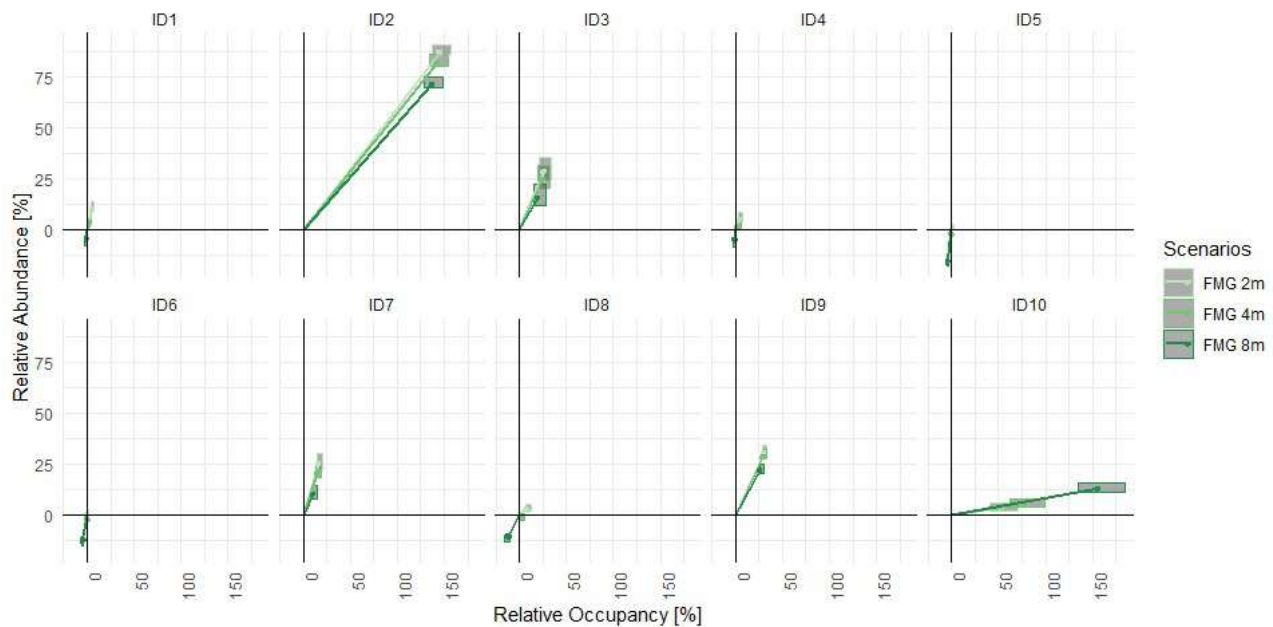


Figure 9.100 Grassy field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7.3 Mixed field margins

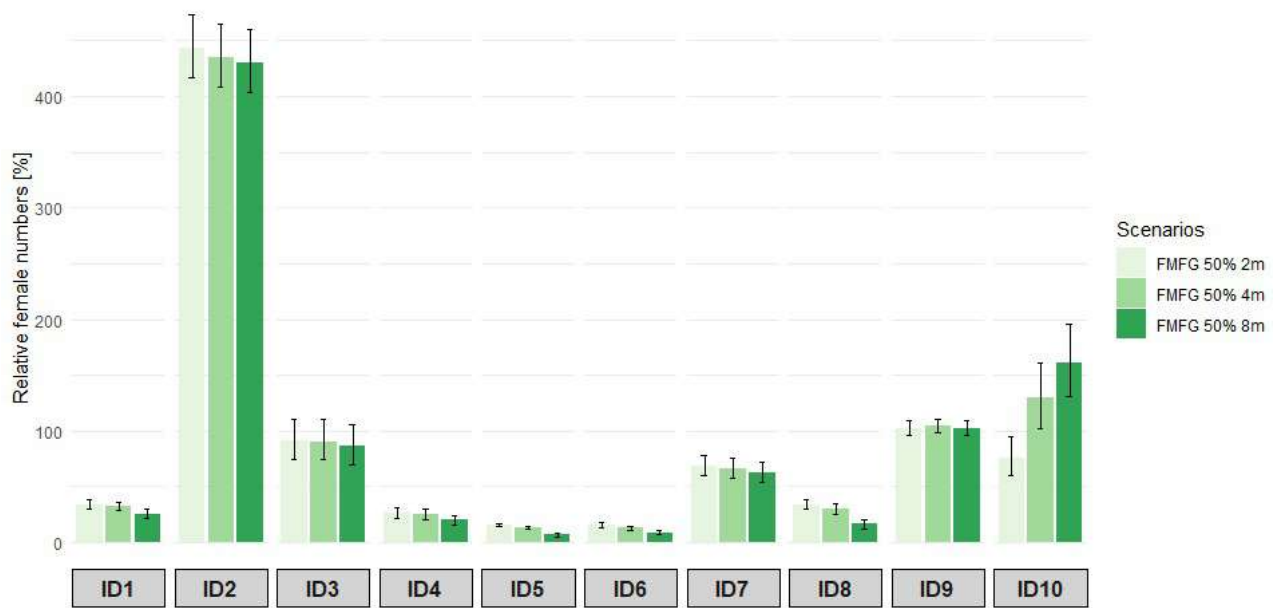


Figure 9.101 Mixed field margins scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

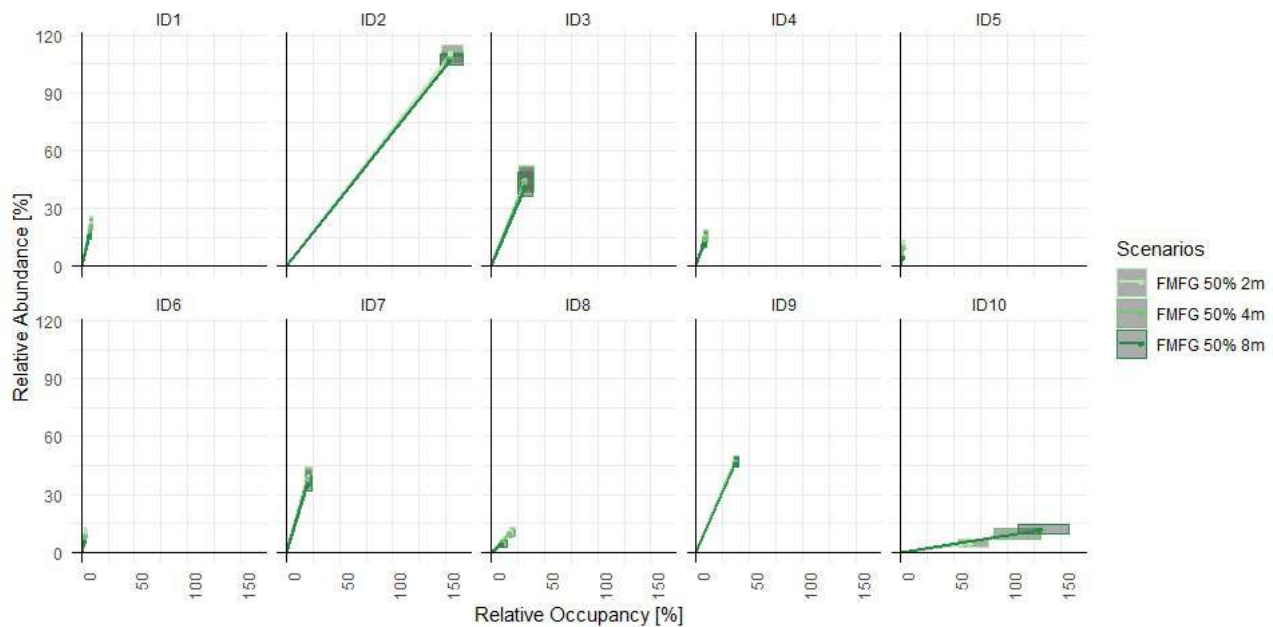


Figure 9.102 Mixed field margins with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7.4 Flower, grassy and mixed field margins

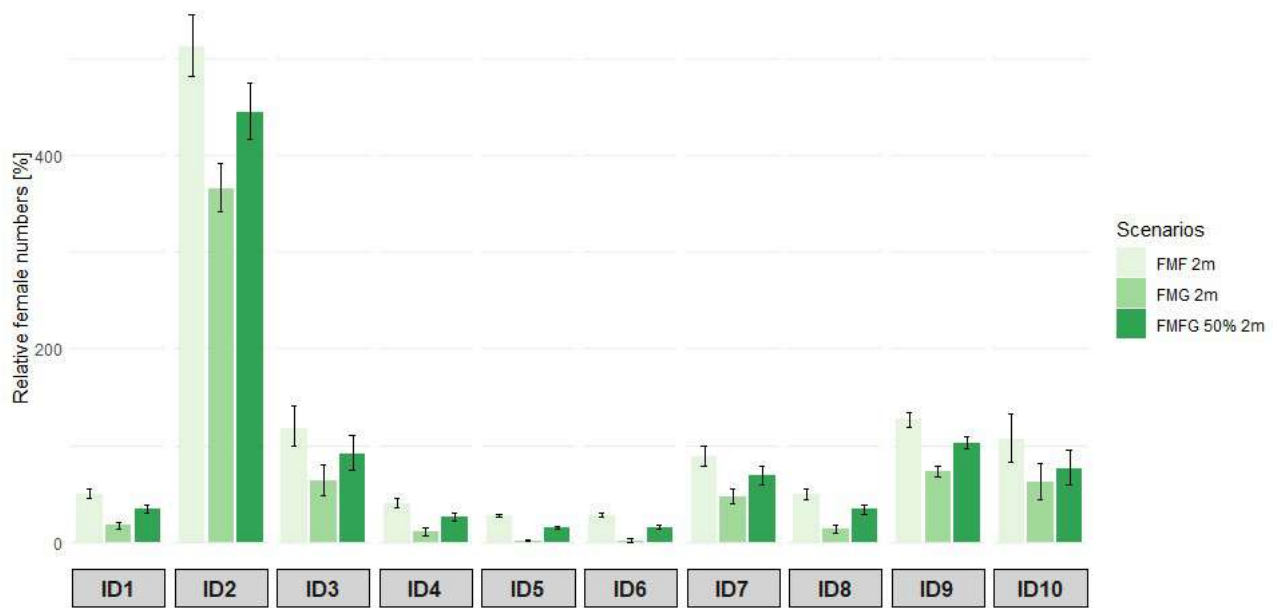


Figure 9.103 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

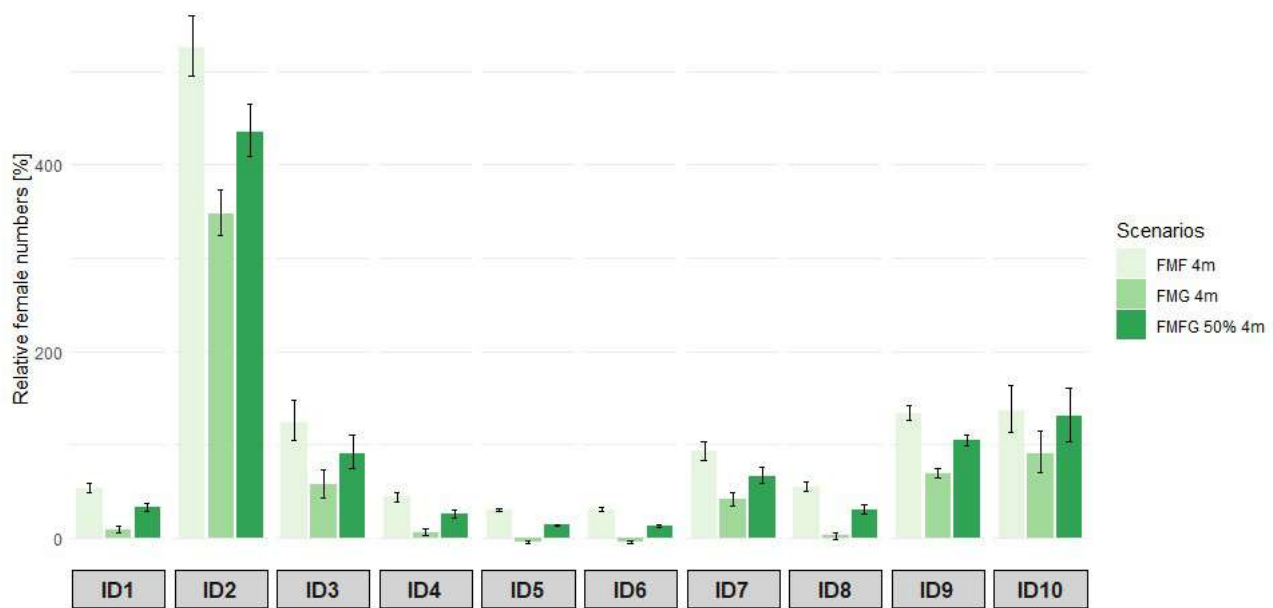


Figure 9.104 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

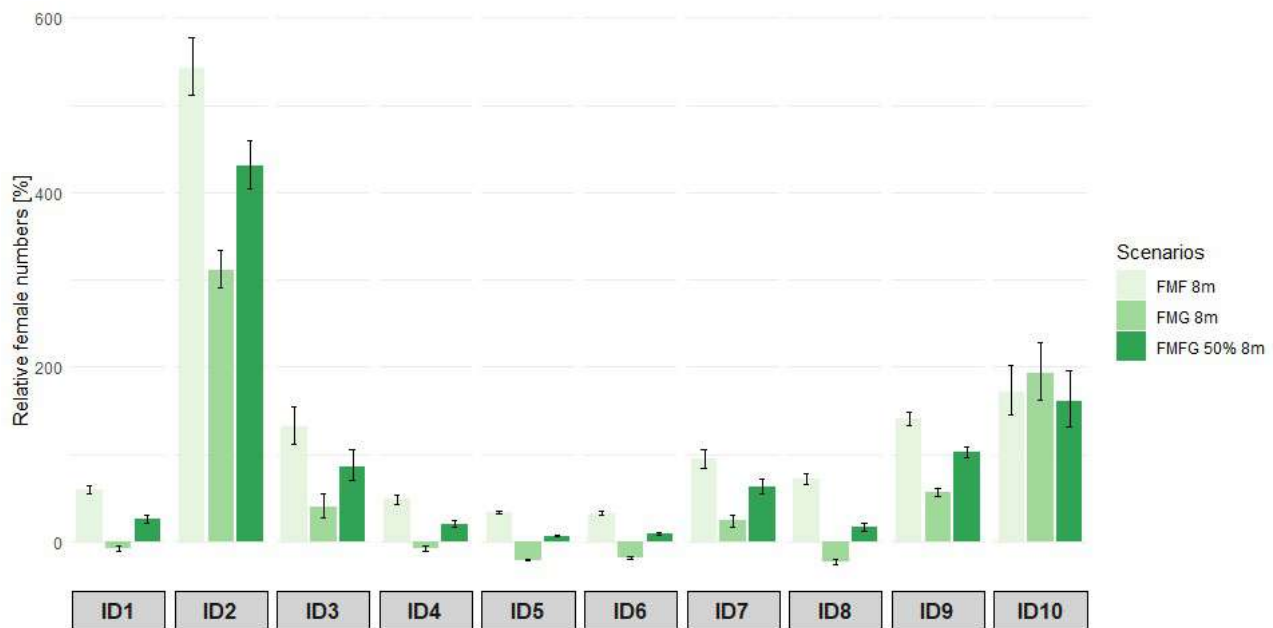


Figure 9.105 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

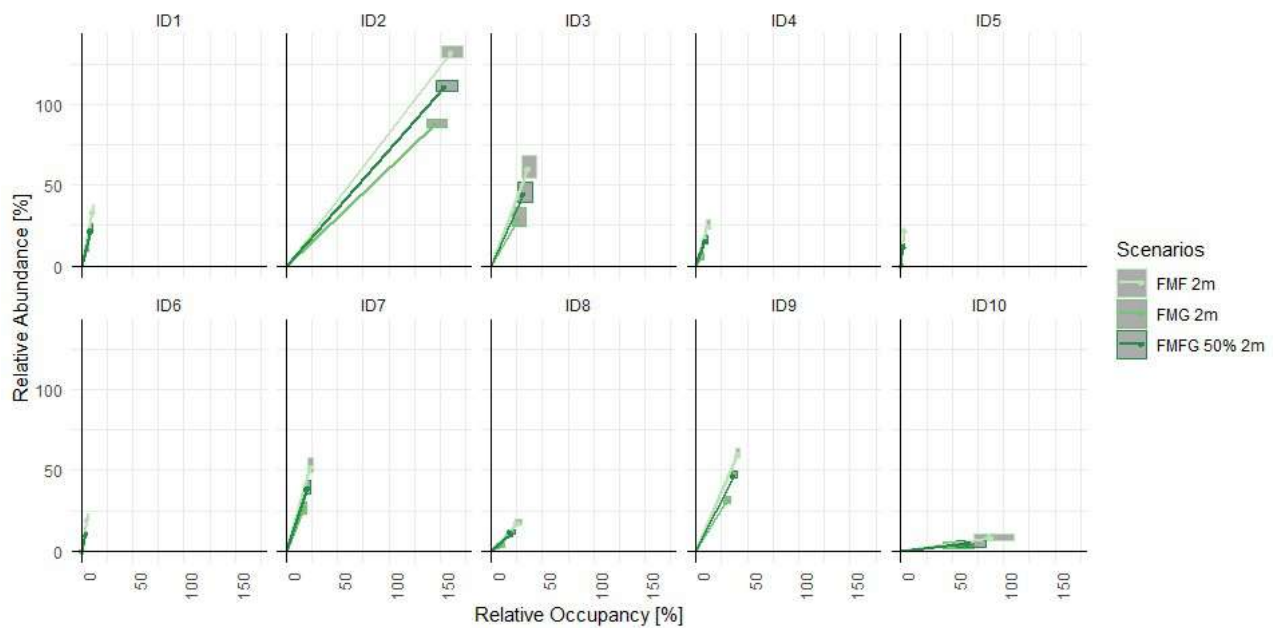


Figure 9.106 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Skylark compared to baseline P(0,0) for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

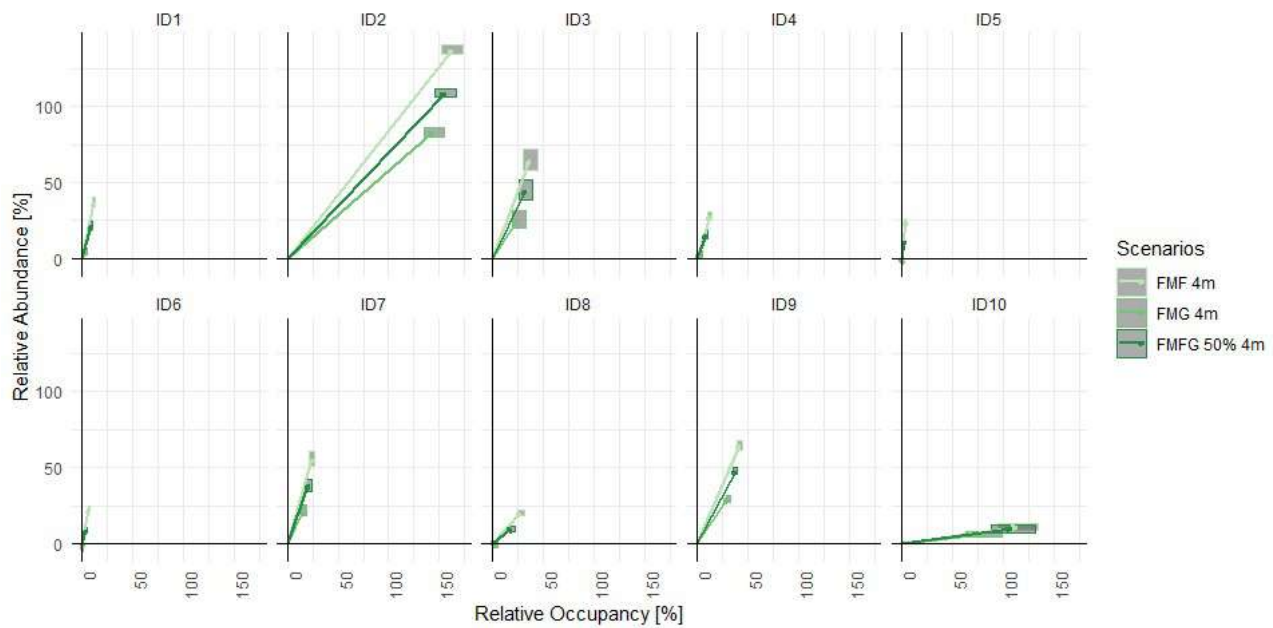


Figure 9.107 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes..

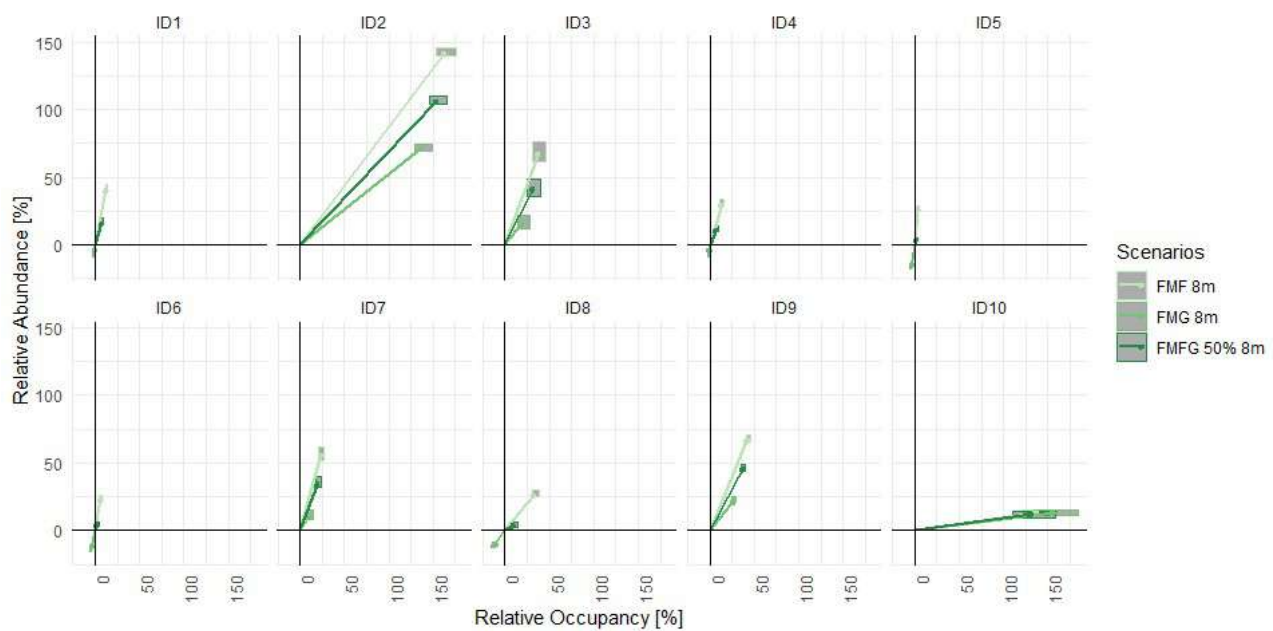


Figure 9.108 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7.5 Setaside

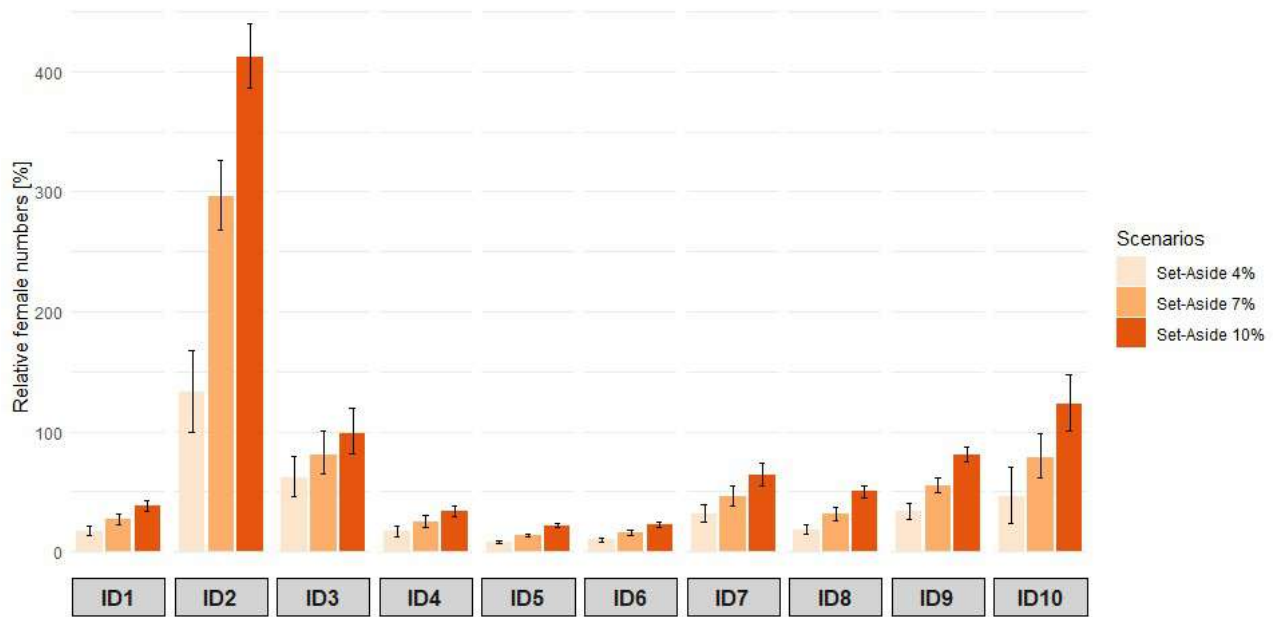


Figure 9.109 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

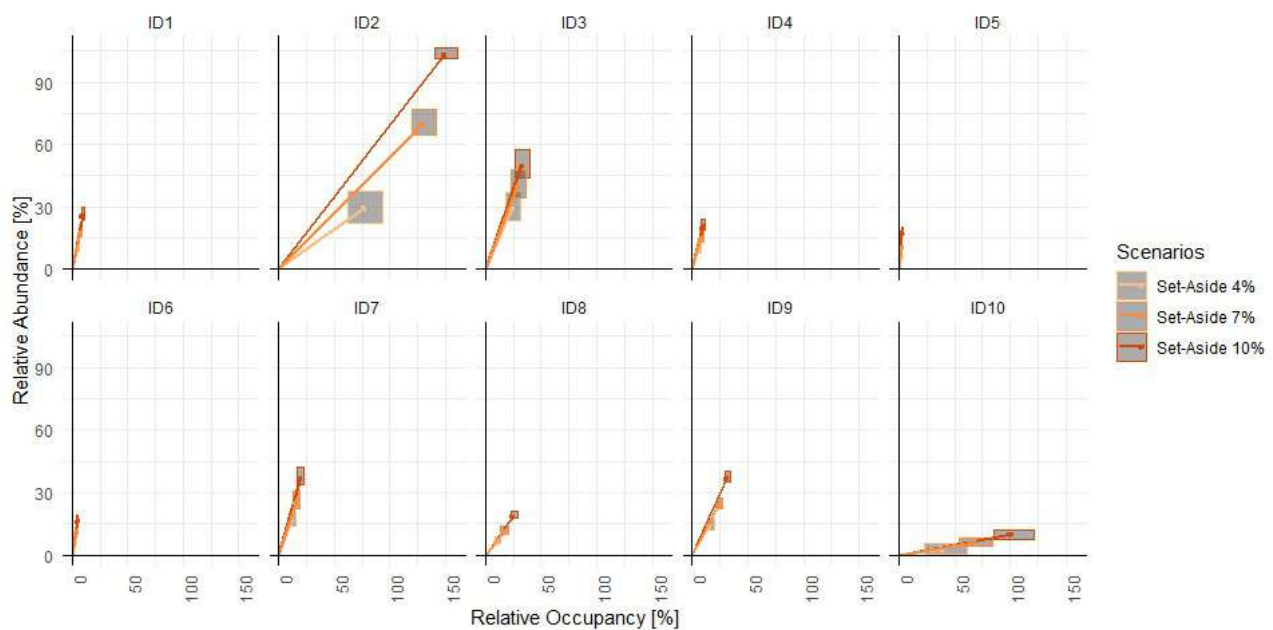


Figure 9.110 Setaside scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7.6 Legume

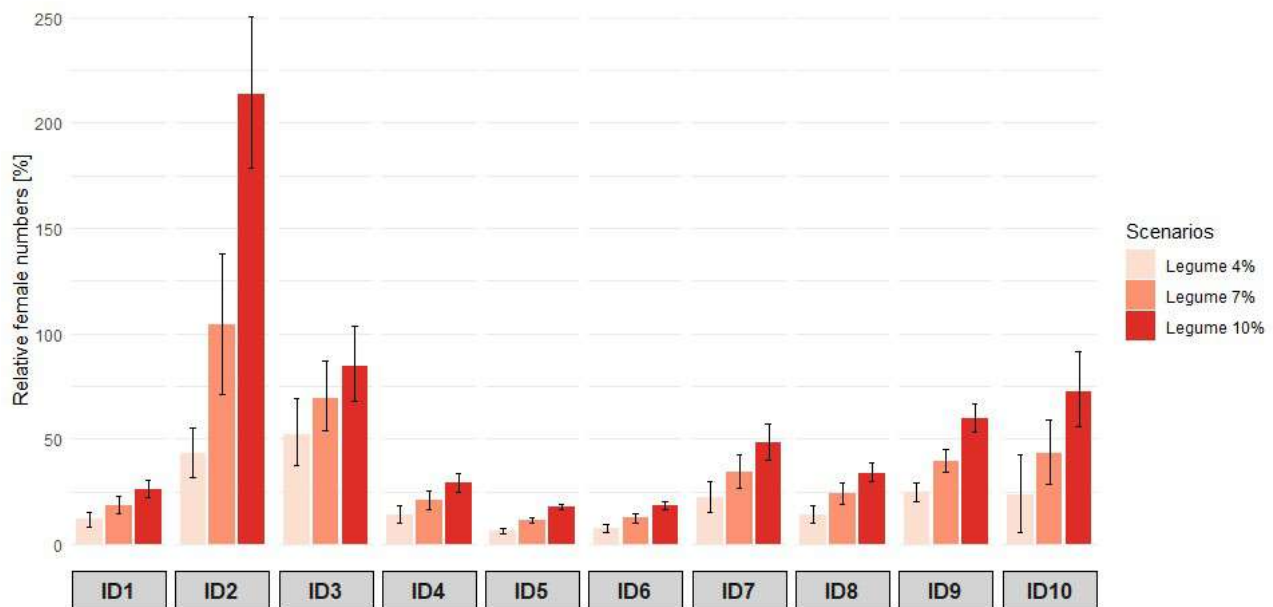


Figure 9.111 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

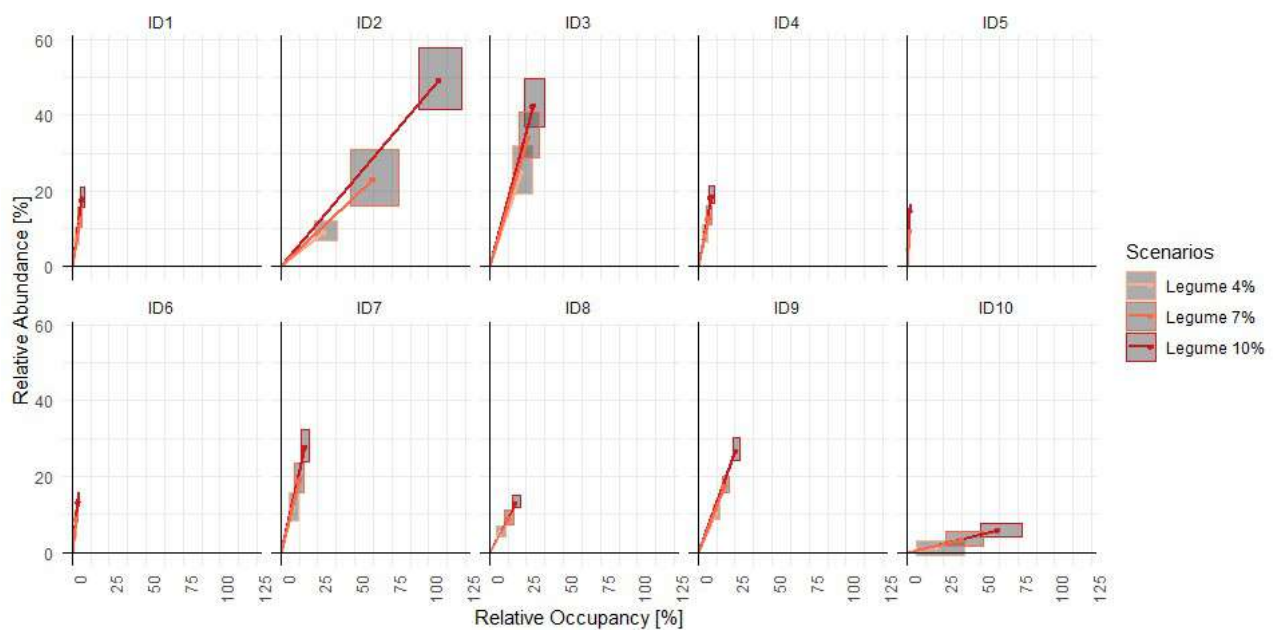


Figure 9.112 Legume scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.7.7 Biopesticides

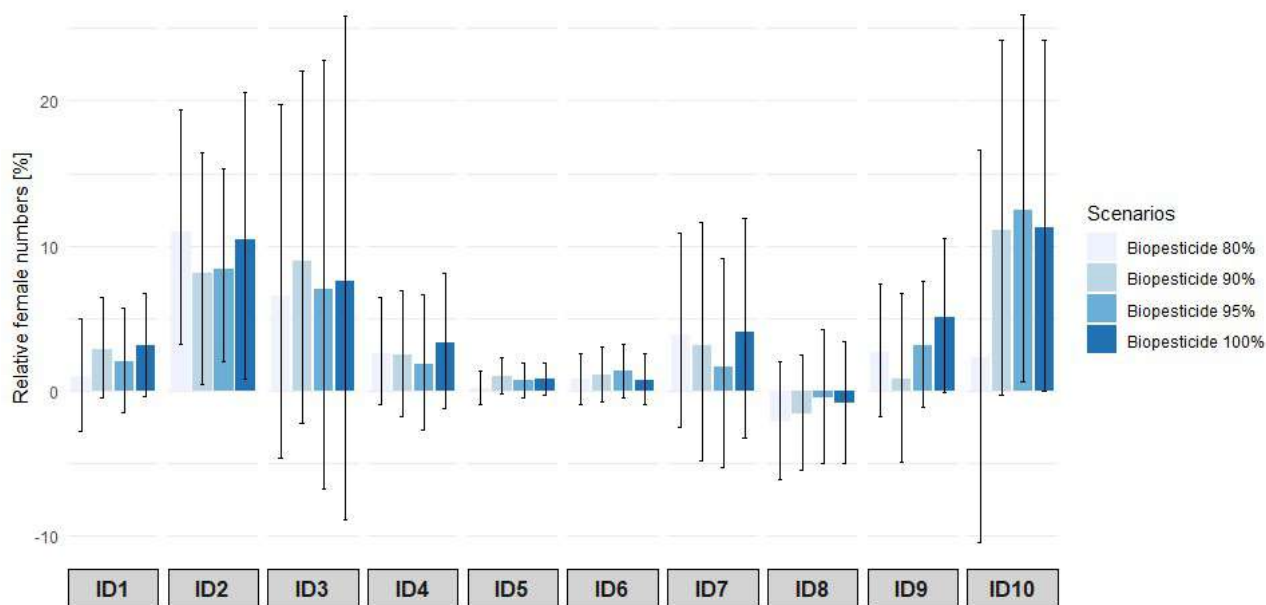


Figure 9.113 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

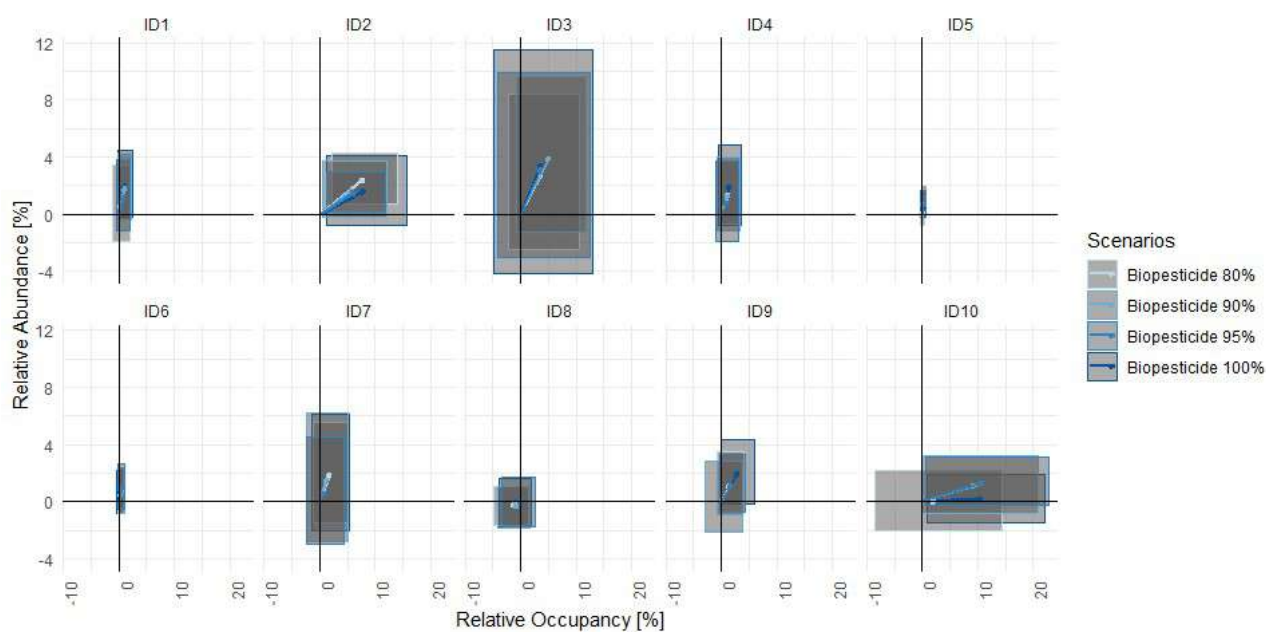


Figure 9.114 Biopesticide scenario with relative change in occupancy and abundance of female Skylark compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 200m resolution. Grey areas indicate standard deviation along both axes.

9.8 Combined landscapes

9.8.1 Crop diversification

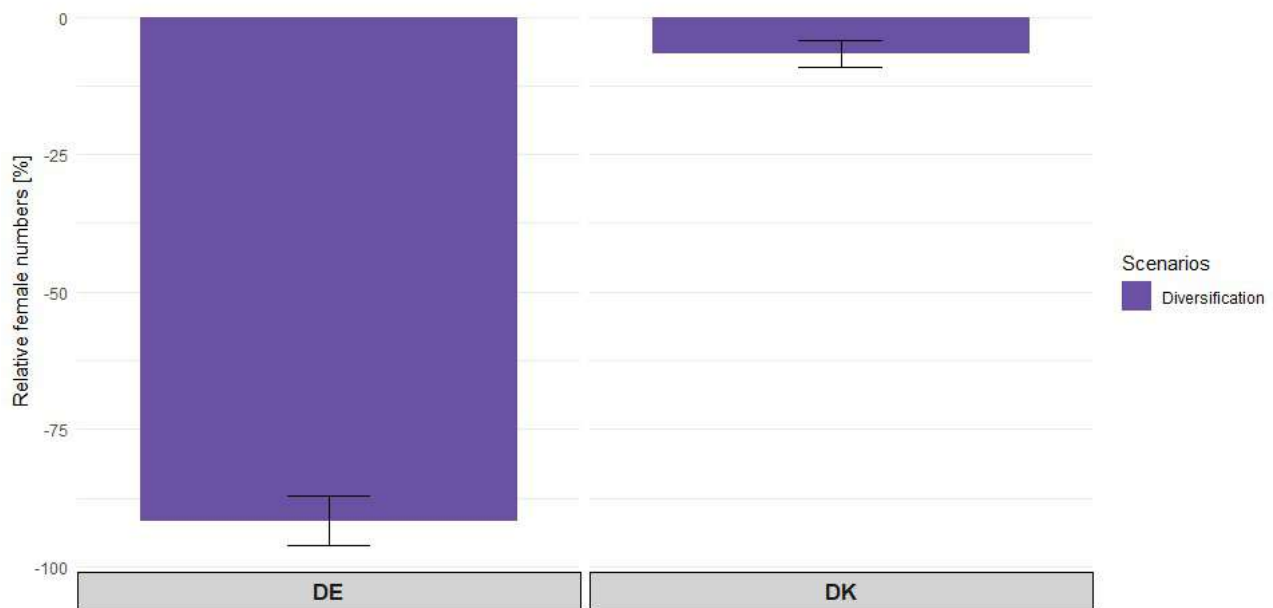


Figure 9.115 Diversification scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.2 Flower field margins

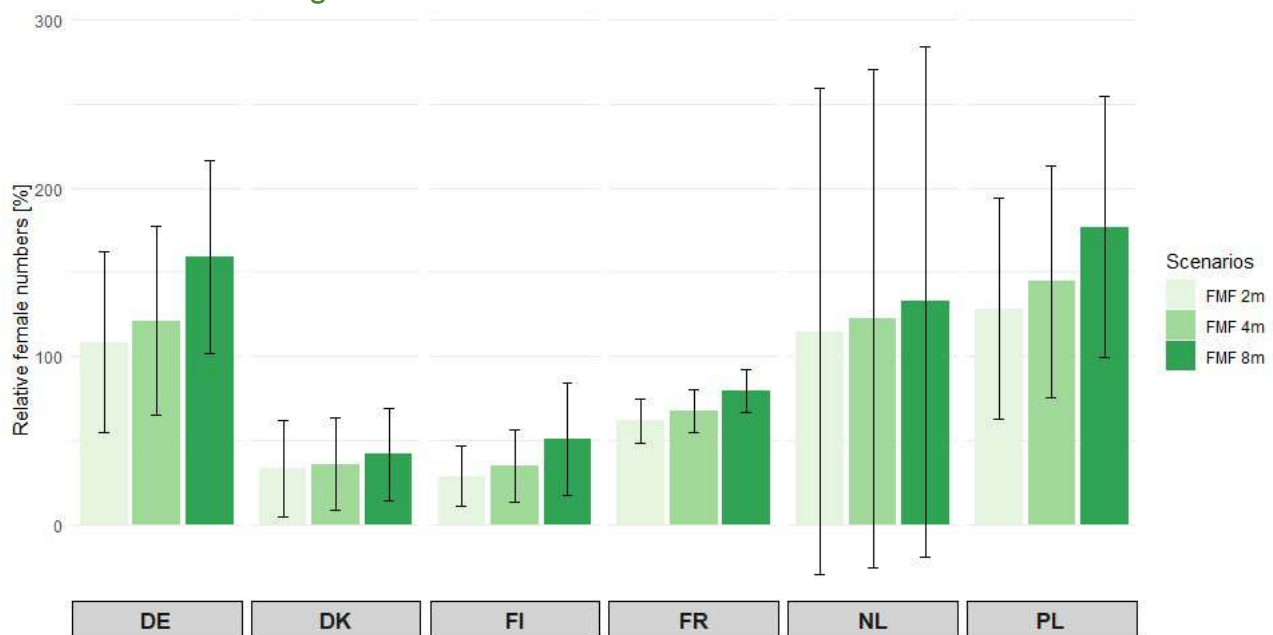


Figure 9.116 Flower field margins with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.3 Grassy field margins

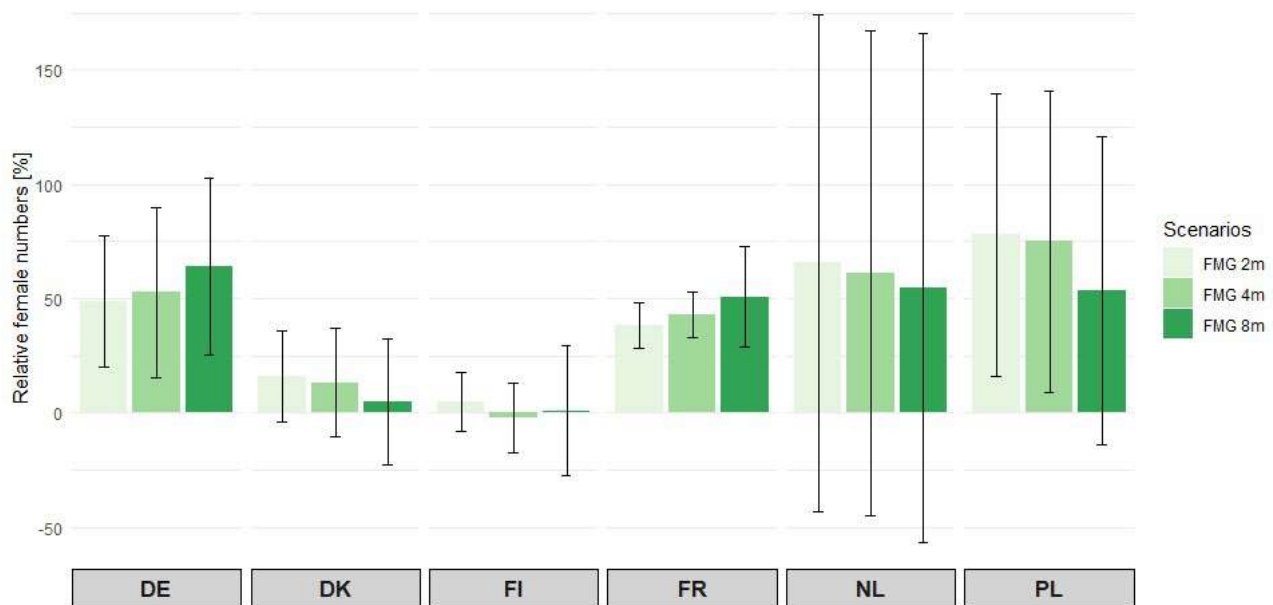


Figure 9.117 Grassy field margins with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.4 Mixed field margins

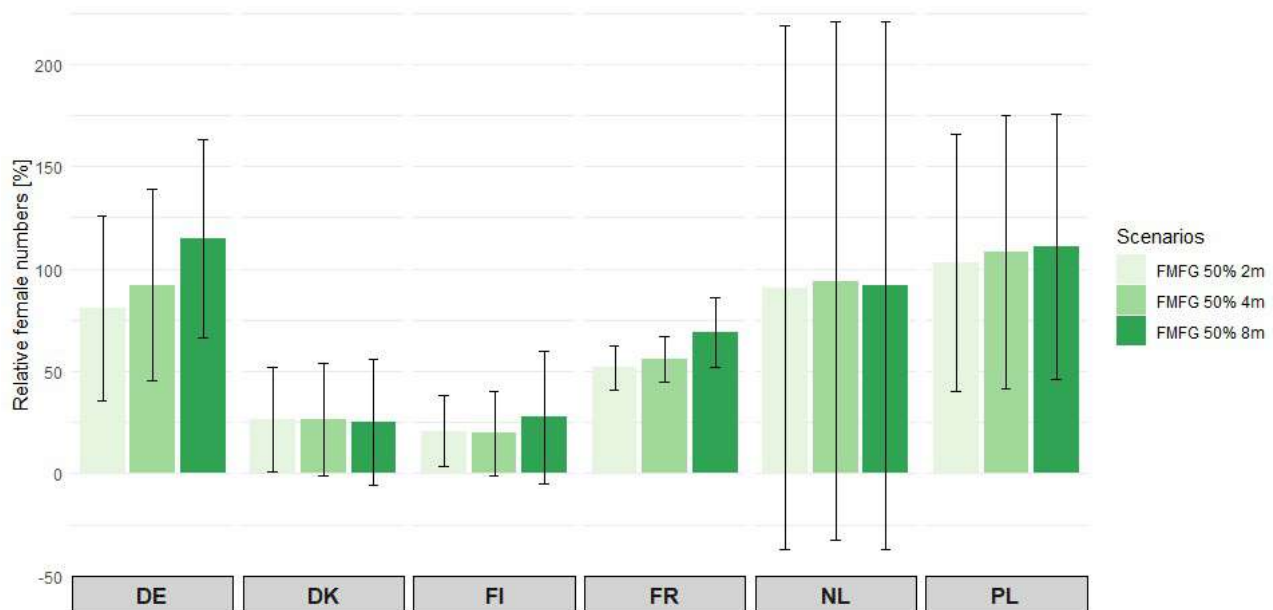


Figure 9.118 Mixed field margins with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.5 Flower, grassy and mixed margins

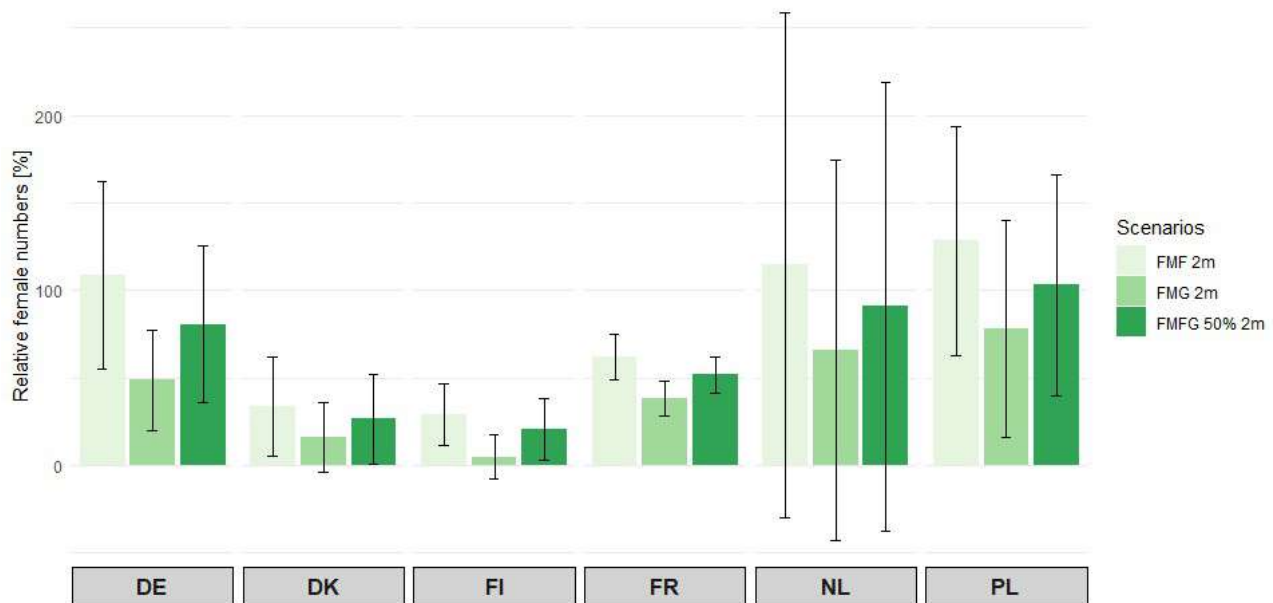


Figure 9.119 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

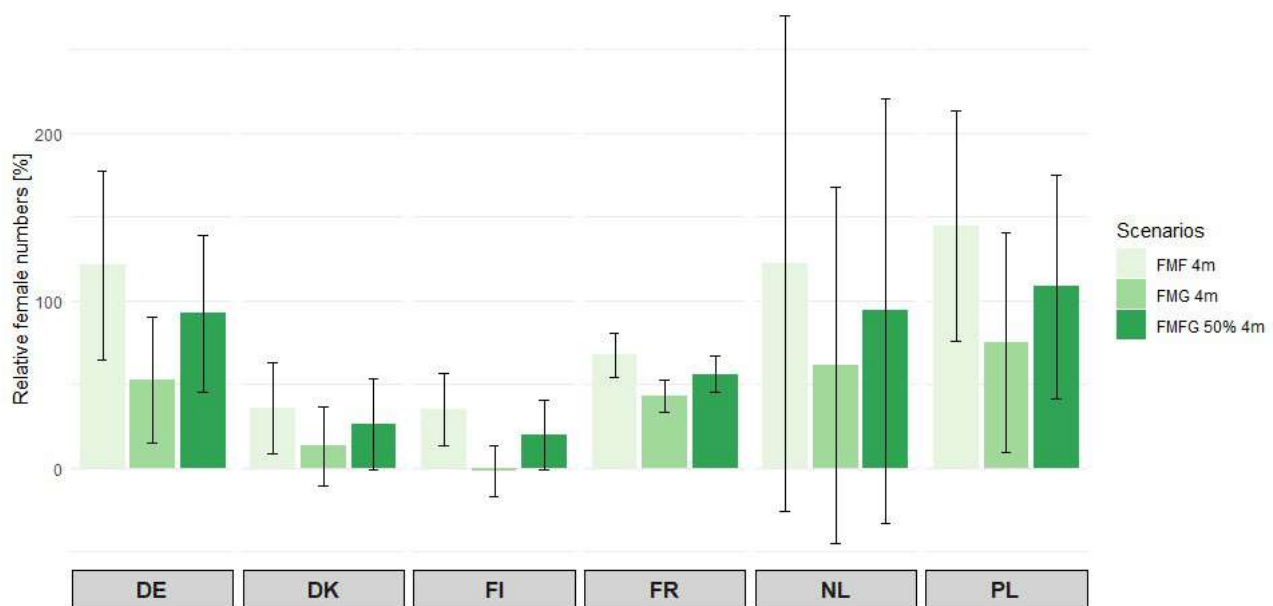


Figure 9.120 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

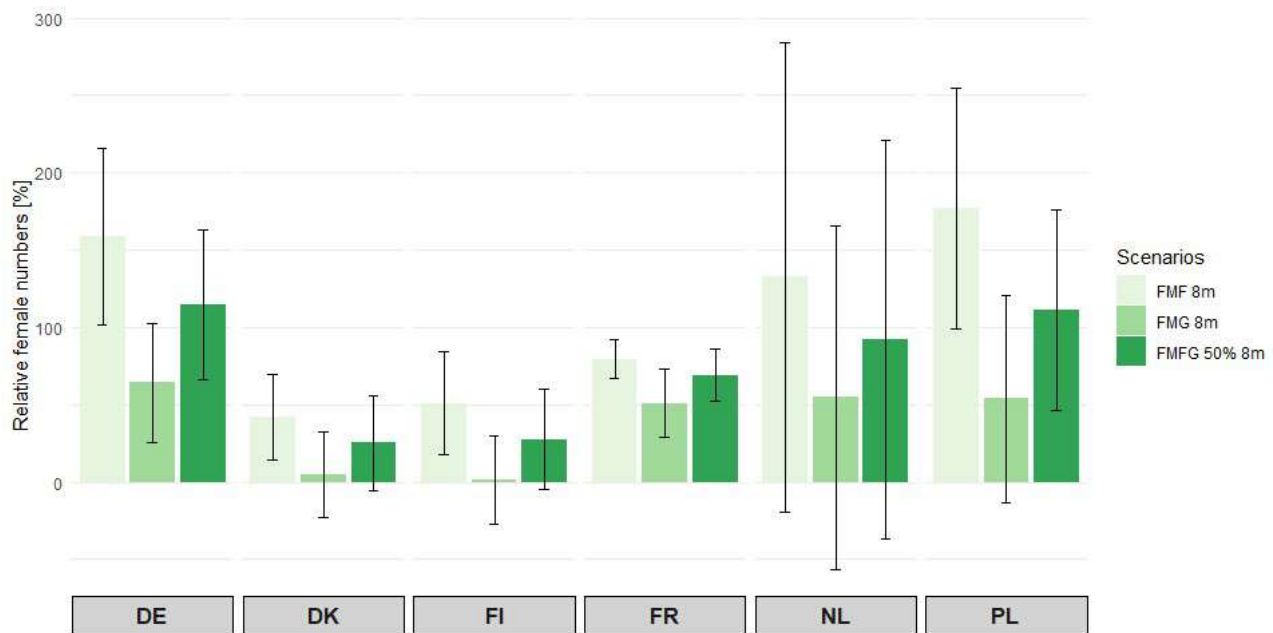


Figure 9.121 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.6 Setaside

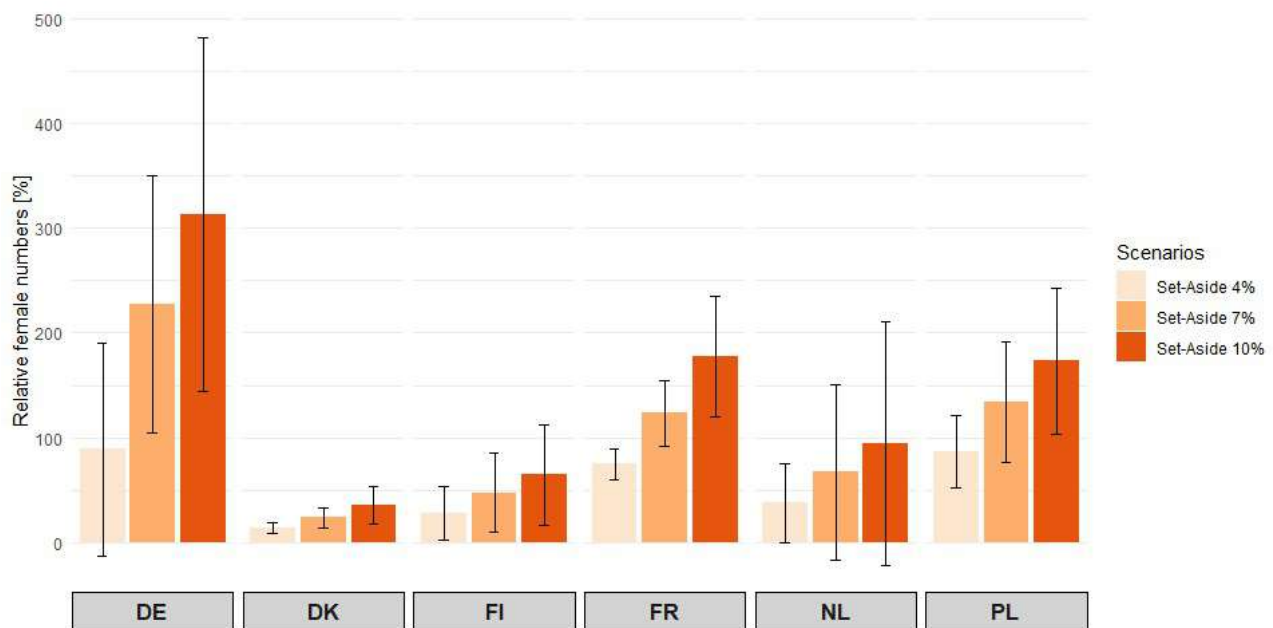


Figure 9.122 Setaside scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.7 Legume

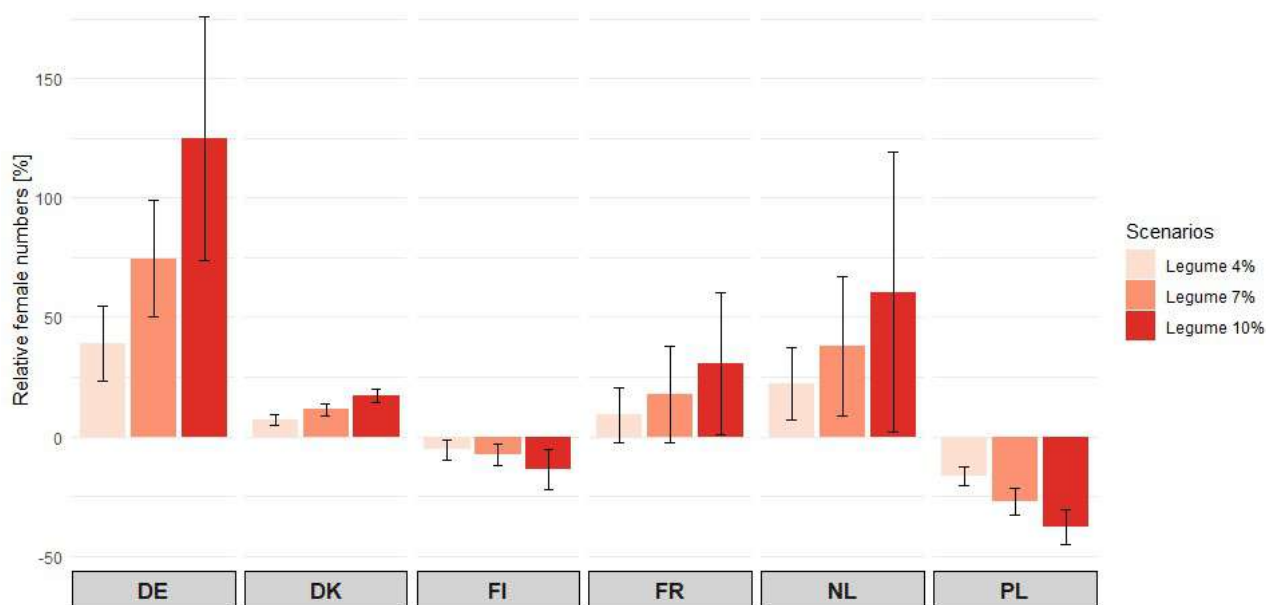


Figure 9.123 Legume scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.8 Biopesticides

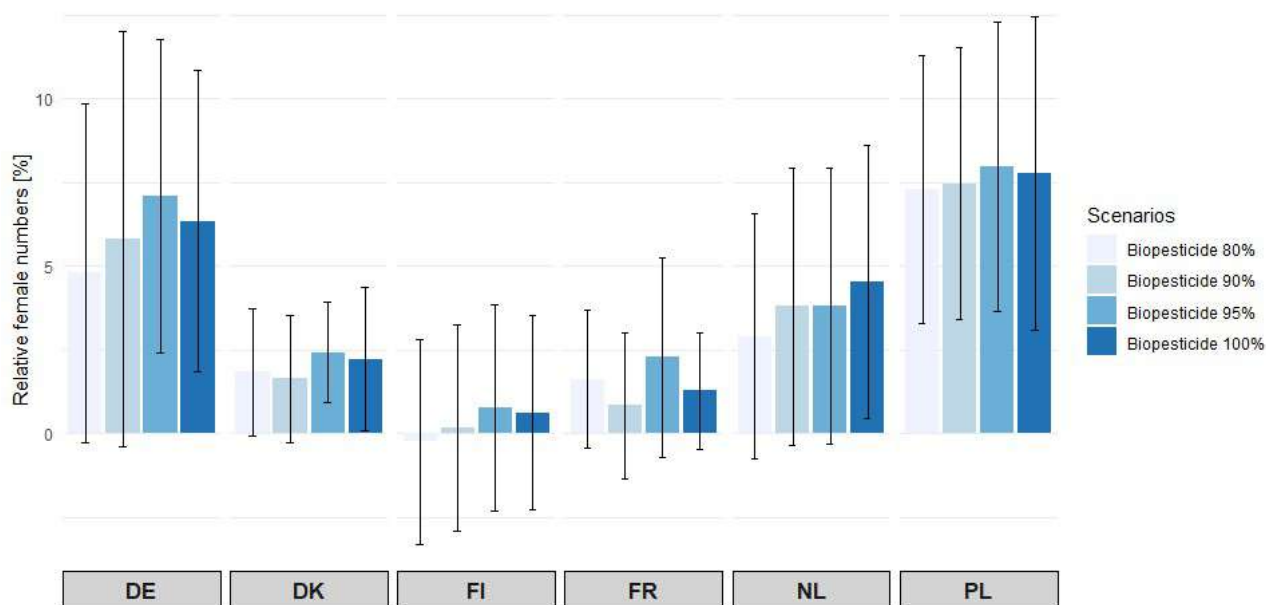


Figure 9.124 Biopesticide scenario with relative change in the number of female Skylark compared to baseline and standard deviation presented by error bars for each simulated country.

9.8.9 Table: Country level overview of scenario effects

Table 9.1 Relative change and standard deviation of scenarios compared to the baseline for each country presented in percentages [%] for Skylark. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	NL	PL	FR	FI
Diversification	-92% (SD 5%)	-7% (SD 2%)	NA	NA	NA	NA
FMF 2m	109% (SD 54%)	34% (SD 29%)	115% (SD 144%)	128% (SD 66%)	62% (SD 13%)	29% (SD 18%)
FMF 4m	121% (SD 56%)	36% (SD 27%)	122% (SD 148%)	145% (SD 69%)	67% (SD 13%)	35% (SD 22%)
FMF 8m	159% (SD 57%)	42% (SD 27%)	133% (SD 152%)	177% (SD 77%)	80% (SD 13%)	51% (SD 33%)
FMG 2m	49% (SD 29%)	16% (SD 20%)	66% (SD 109%)	78% (SD 62%)	38% (SD 10%)	5% (SD 13%)
FMG 4m	53% (SD 37%)	13% (SD 24%)	61% (SD 106%)	75% (SD 66%)	43% (SD 10%)	-2% (SD 15%)
FMG 8m	64% (SD 39%)	5% (SD 28%)	55% (SD 111%)	54% (SD 67%)	51% (SD 22%)	1% (SD 28%)
FMFG 50% 2m	81% (SD 45%)	26% (SD 25%)	91% (SD 128%)	103% (SD 63%)	52% (SD 11%)	21% (SD 17%)
FMFG 50% 4m	92% (SD 47%)	26% (SD 27%)	94% (SD 127%)	108% (SD 67%)	56% (SD 11%)	20% (SD 21%)
FMFG 50% 8m	115% (SD 48%)	25% (SD 31%)	92% (SD 129%)	111% (SD 65%)	69% (SD 17%)	28% (SD 33%)
Set-Aside 4%	89% (SD 101%)	13% (SD 5%)	38% (SD 38%)	87% (SD 34%)	75% (SD 15%)	28% (SD 26%)
Set-Aside 7%	227% (SD 123%)	24% (SD 10%)	67% (SD 84%)	134% (SD 57%)	123% (SD 31%)	47% (SD 38%)
Set-Aside 10%	314% (SD 169%)	36% (SD 18%)	94% (SD 117%)	173% (SD 70%)	178% (SD 57%)	65% (SD 48%)
Legume 4%	39% (SD 16%)	7% (SD 2%)	22% (SD 15%)	-17% (SD 4%)	9% (SD 11%)	-6% (SD 4%)
Legume 7%	75% (SD 24%)	11% (SD 3%)	38% (SD 29%)	-27% (SD 6%)	18% (SD 20%)	-8% (SD 5%)
Legume 10%	125% (SD 51%)	17% (SD 3%)	61% (SD 59%)	-38% (SD 7%)	31% (SD 30%)	-14% (SD 8%)
Bio-pesticide 80%	5% (SD 5%)	2% (SD 2%)	3% (SD 4%)	7% (SD 4%)	2% (SD 2%)	-0% (SD 3%)

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Scenario	DE	DK	NL	PL	FR	FI
Bio-pesticide 90%	6% (SD 6%)	2% (SD 2%)	4% (SD 4%)	7% (SD 4%)	1% (SD 2%)	0% (SD 3%)
Bio-pesticide 95%	7% (SD 5%)	2% (SD 1%)	4% (SD 4%)	8% (SD 4%)	2% (SD 3%)	1% (SD 3%)
Bio-pesticide 100%	6% (SD 5%)	2% (SD 2%)	5% (SD 4%)	8% (SD 5%)	1% (SD 2%)	1% (SD 3%)

10 VOLE

10.1 Baselines

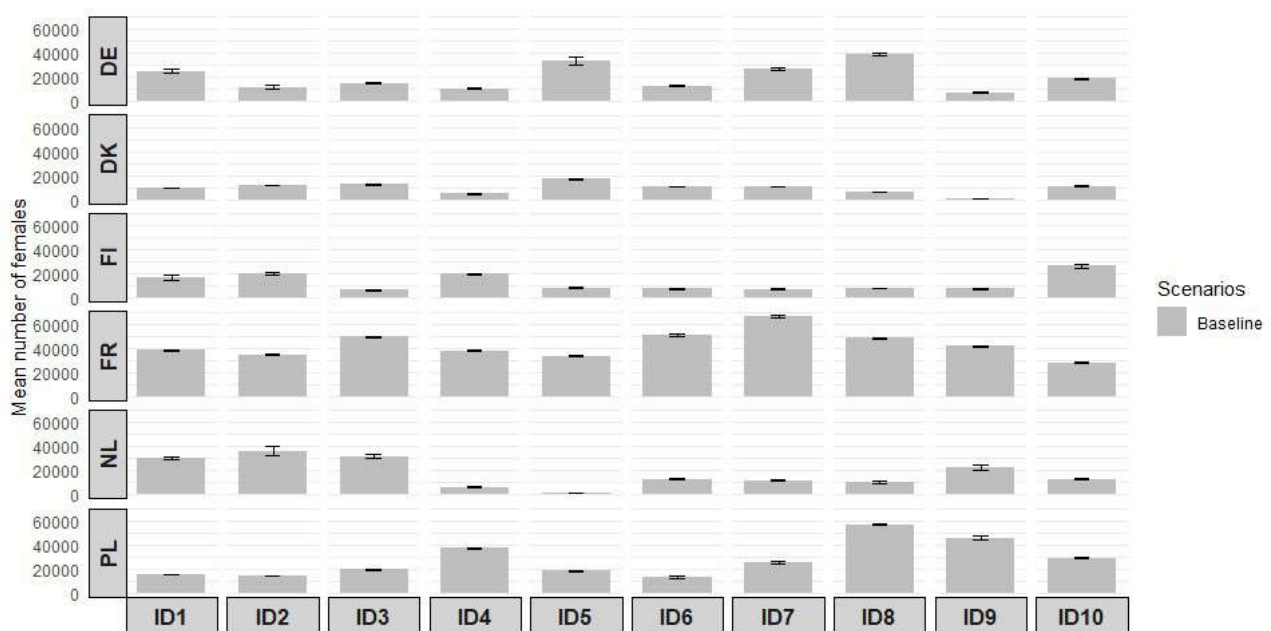


Figure 10.1 Vole baselines for each country and landscape.

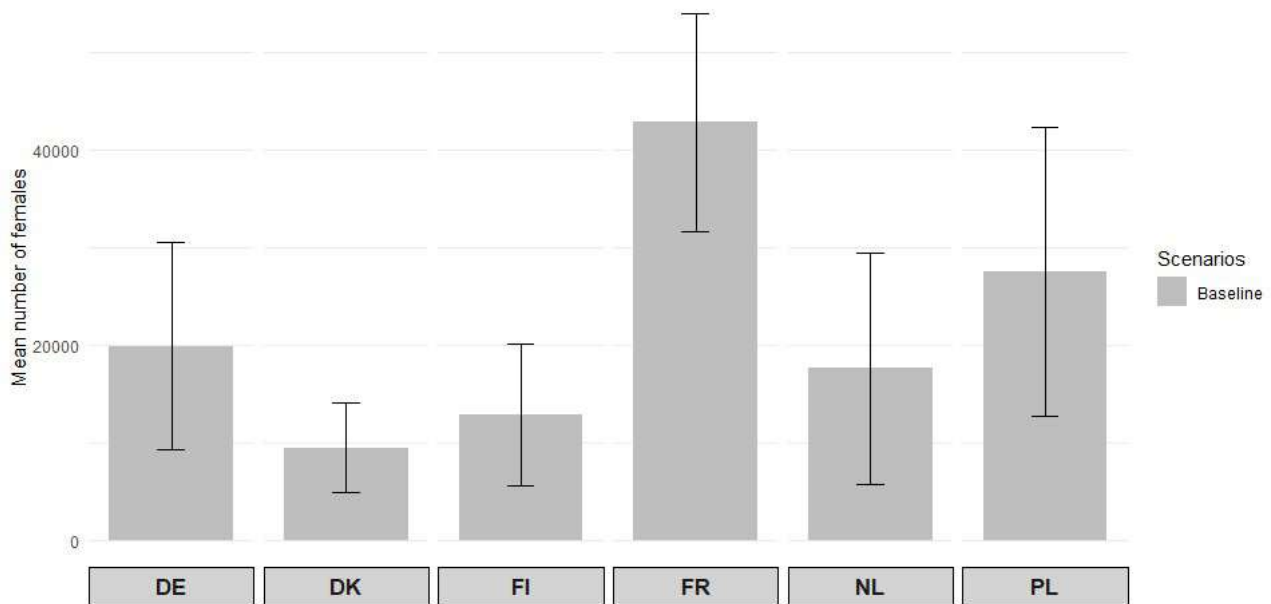


Figure 10.2 Vole baselines for each country combined across landscapes.

10.2 Germany

10.2.1 Crop diversification

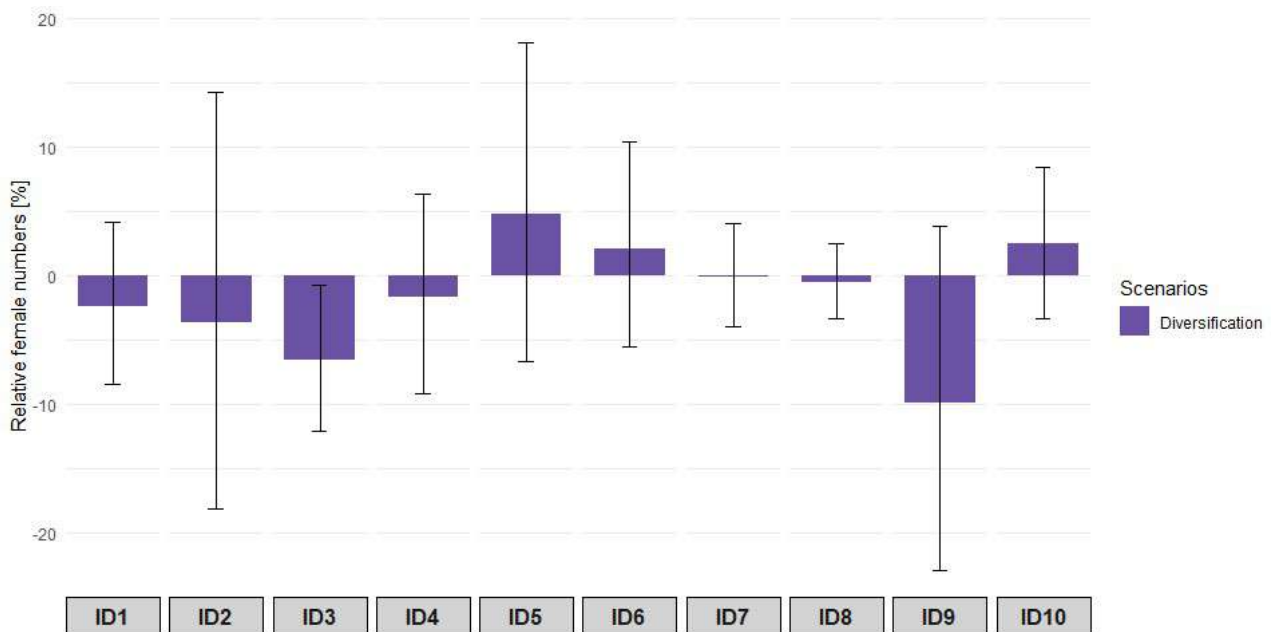


Figure 10.3 Diversification scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

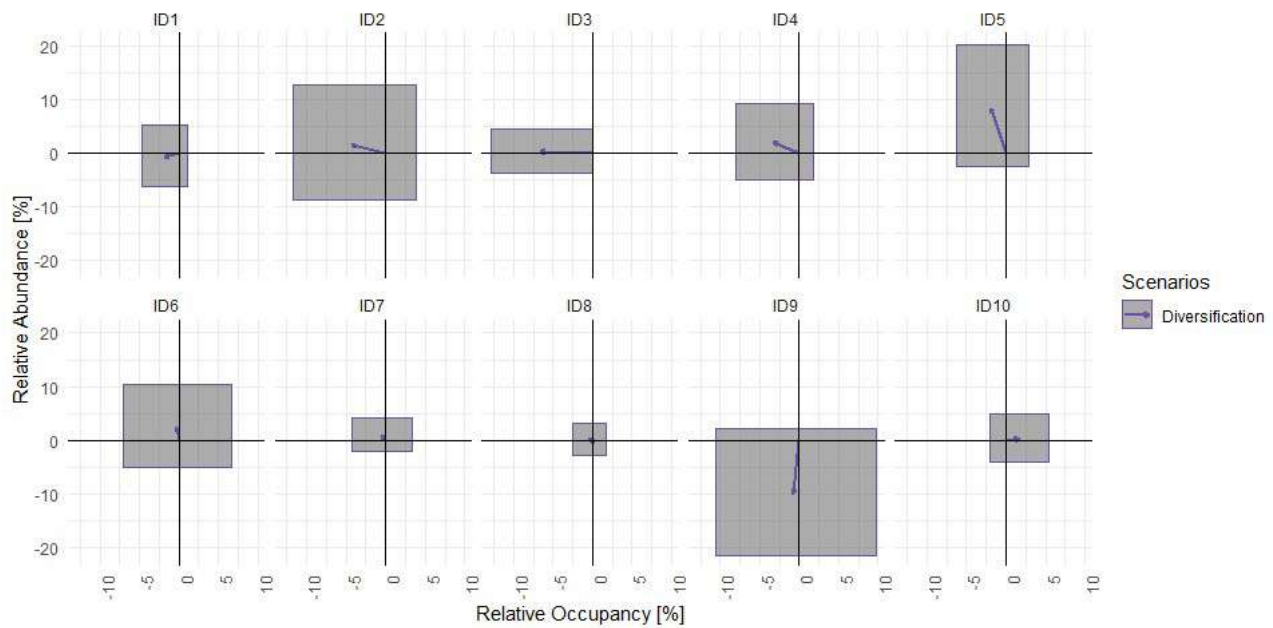


Figure 10.4 Diversification scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.2 Flower field margins

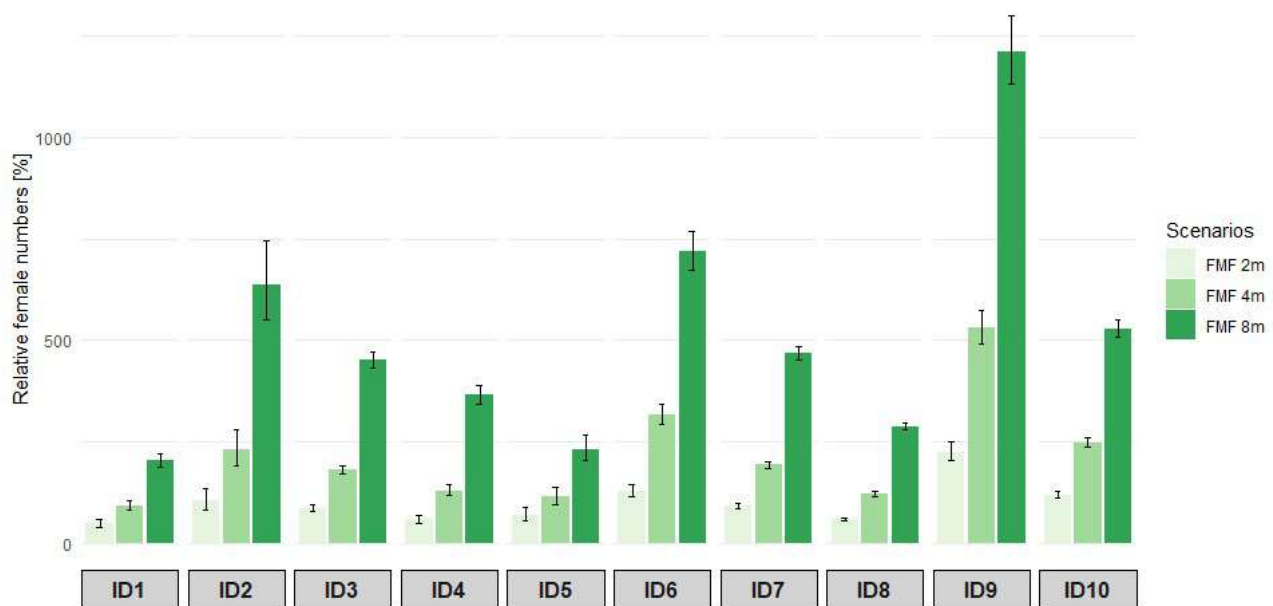


Figure 10.5 Flower field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

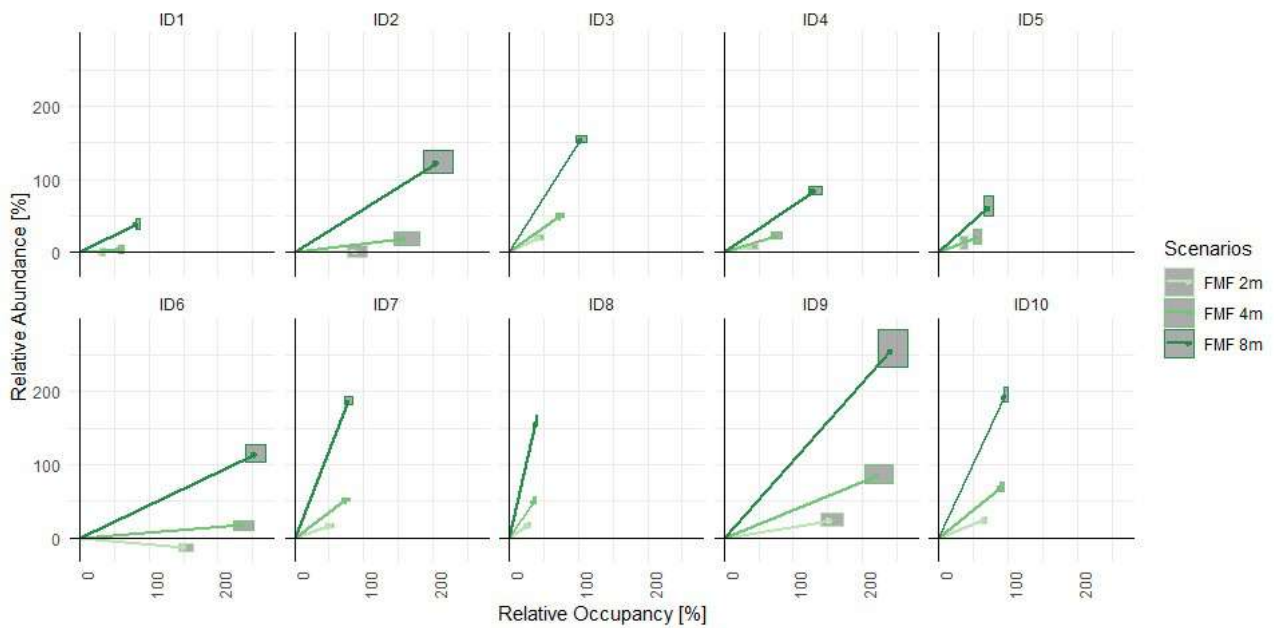


Figure 10.6 Flower field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.3 Grassy field margins

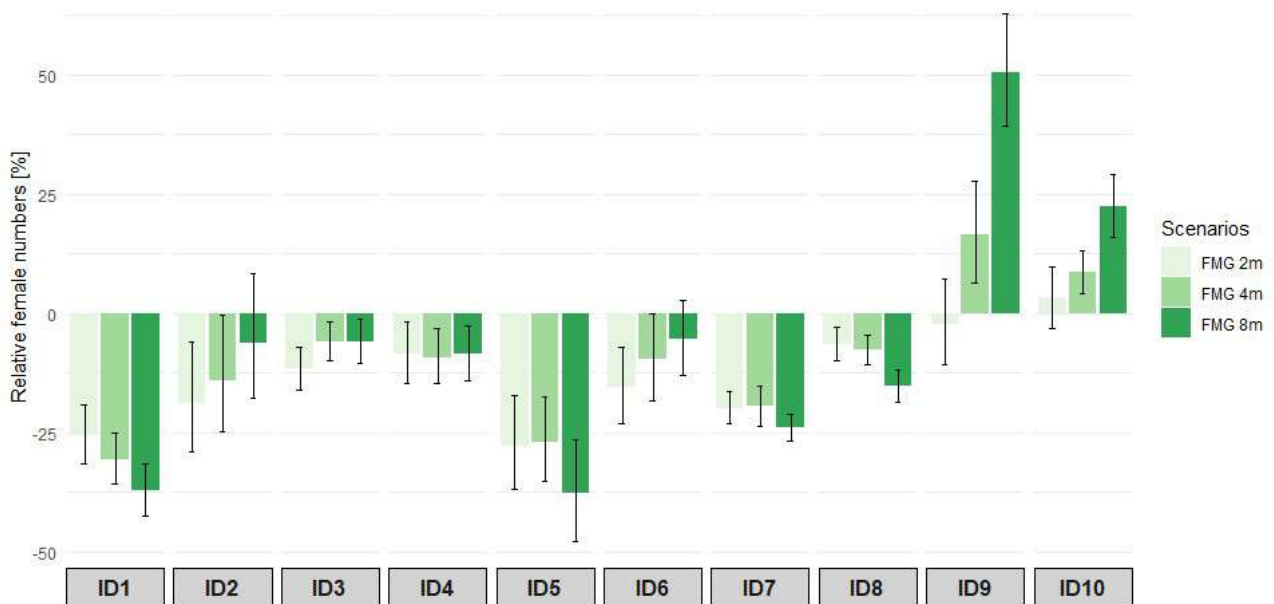


Figure 10.7 Grassy field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

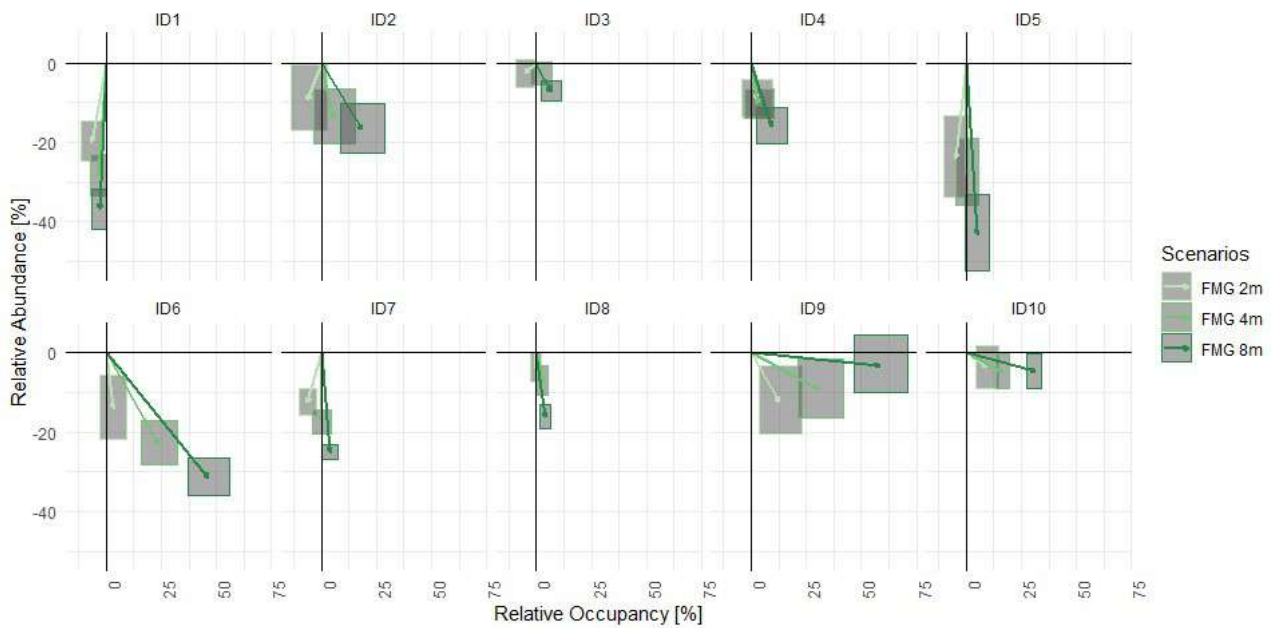


Figure 10.8 Grassy field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.4 Mixed field margins

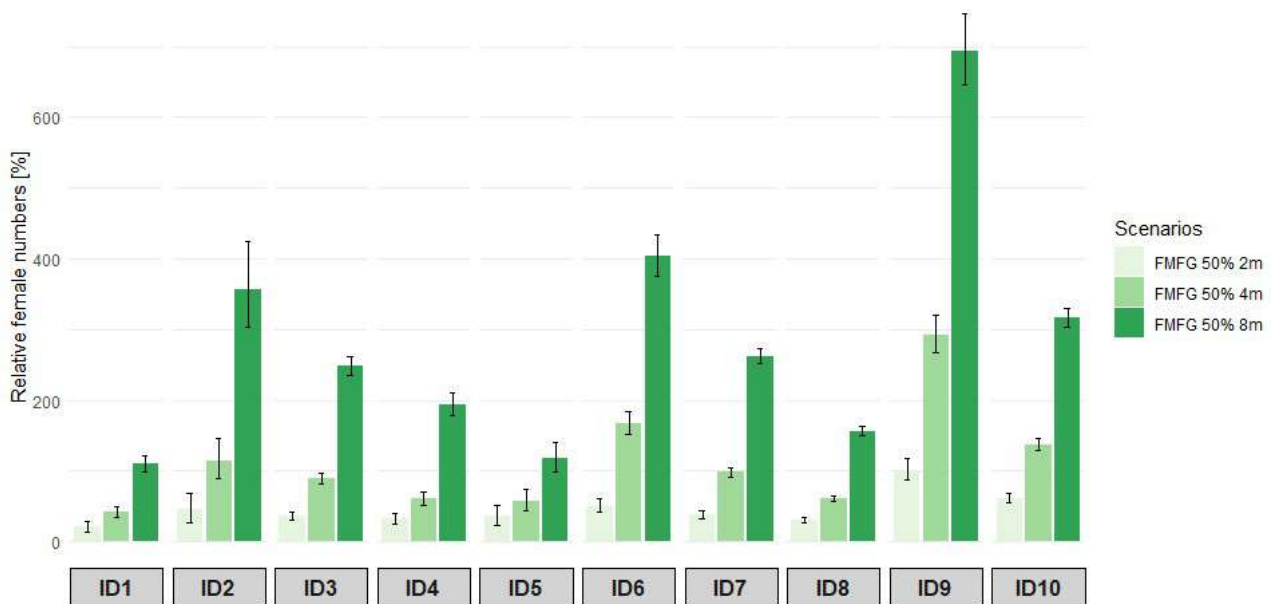


Figure 10.9 Mixed field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

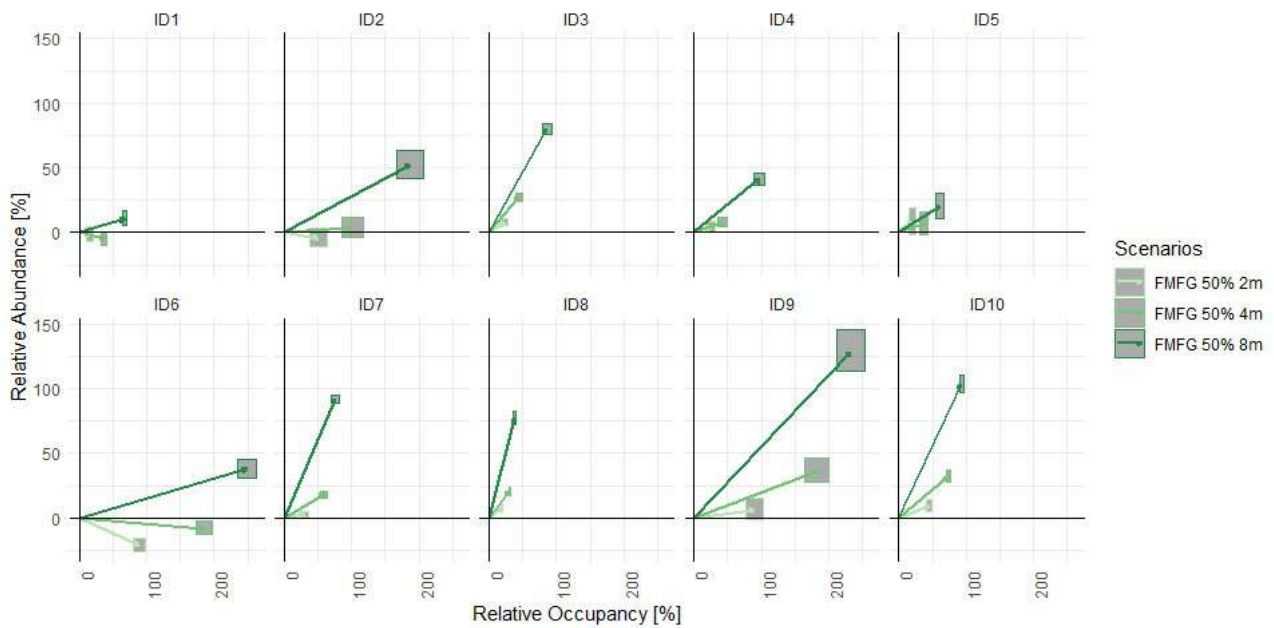


Figure 10.10 Mixed field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.5 Flower, grassy and mixed field margins

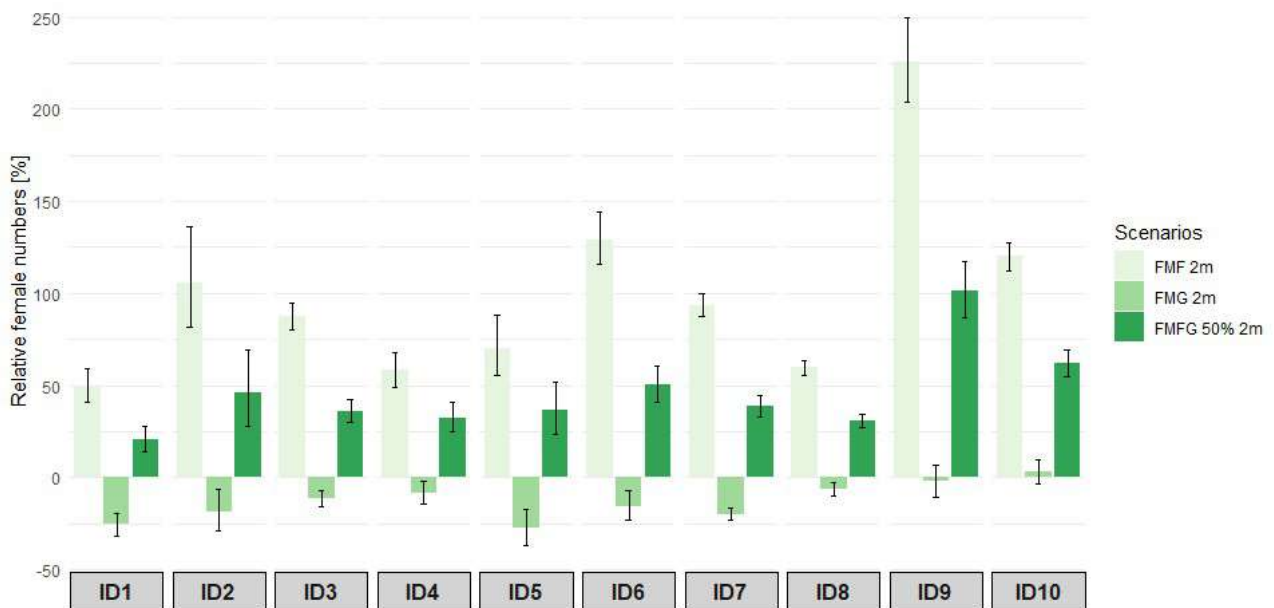


Figure 10.11 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

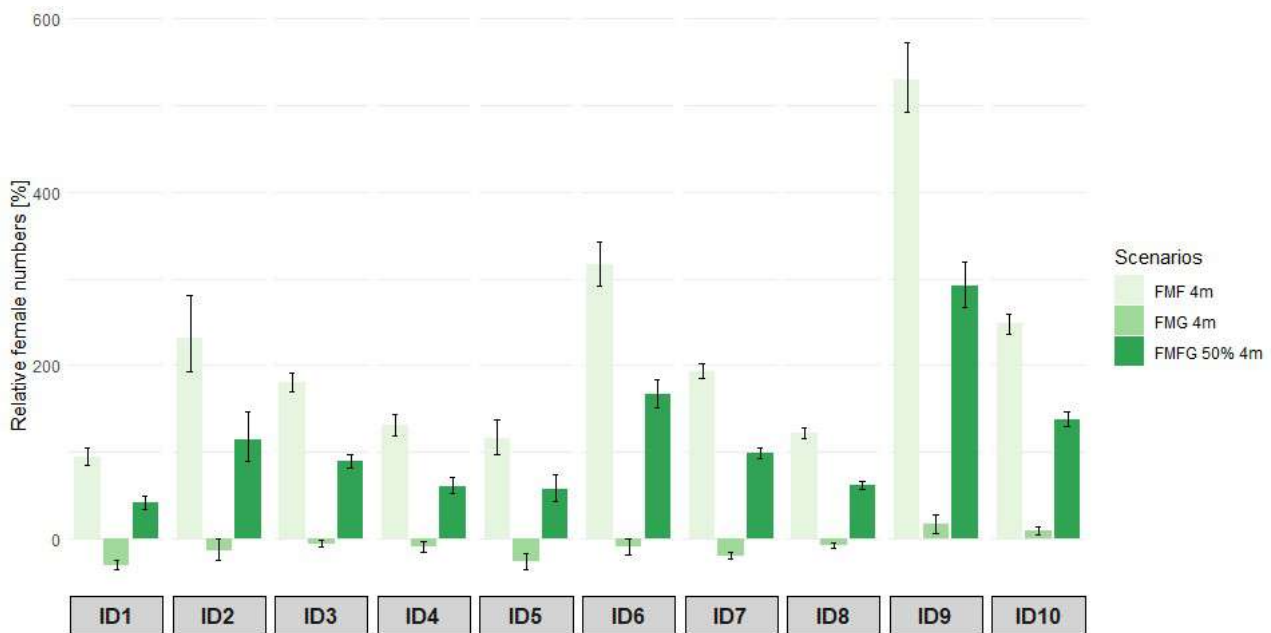


Figure 10.12 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

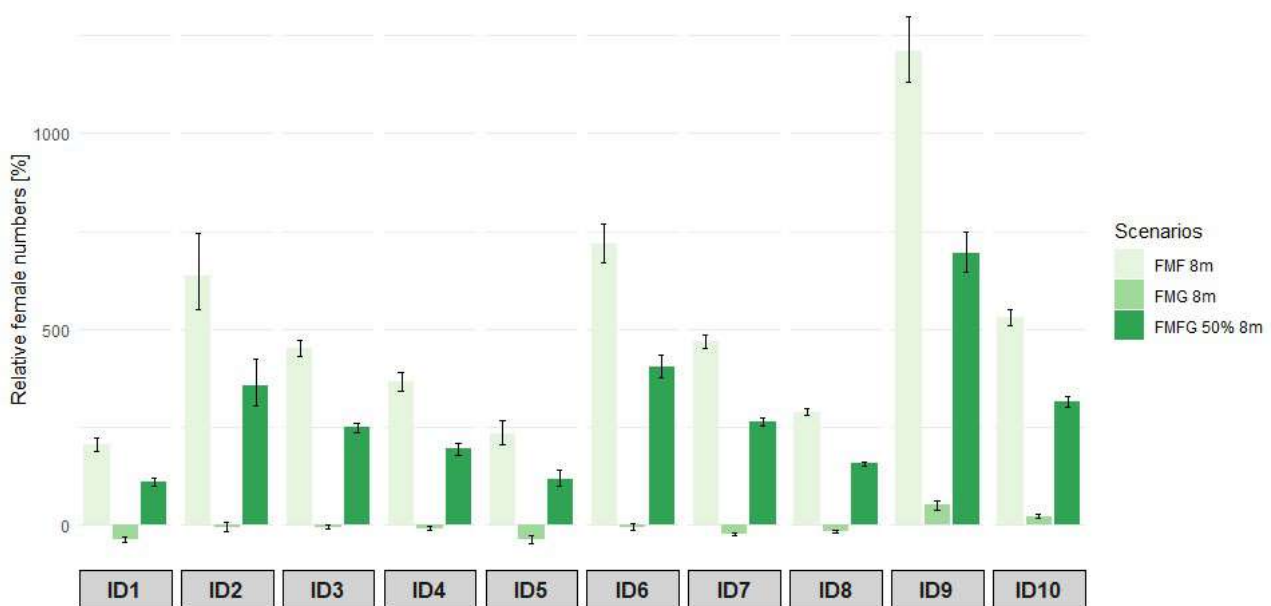


Figure 10.13 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

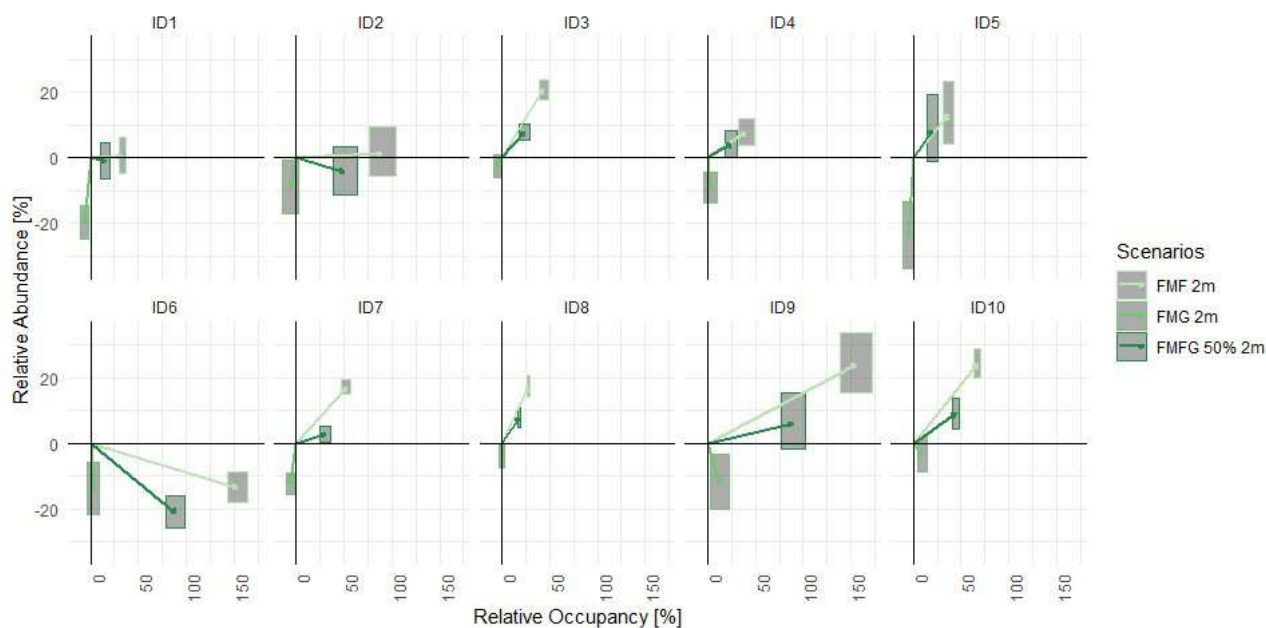


Figure 10.14 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

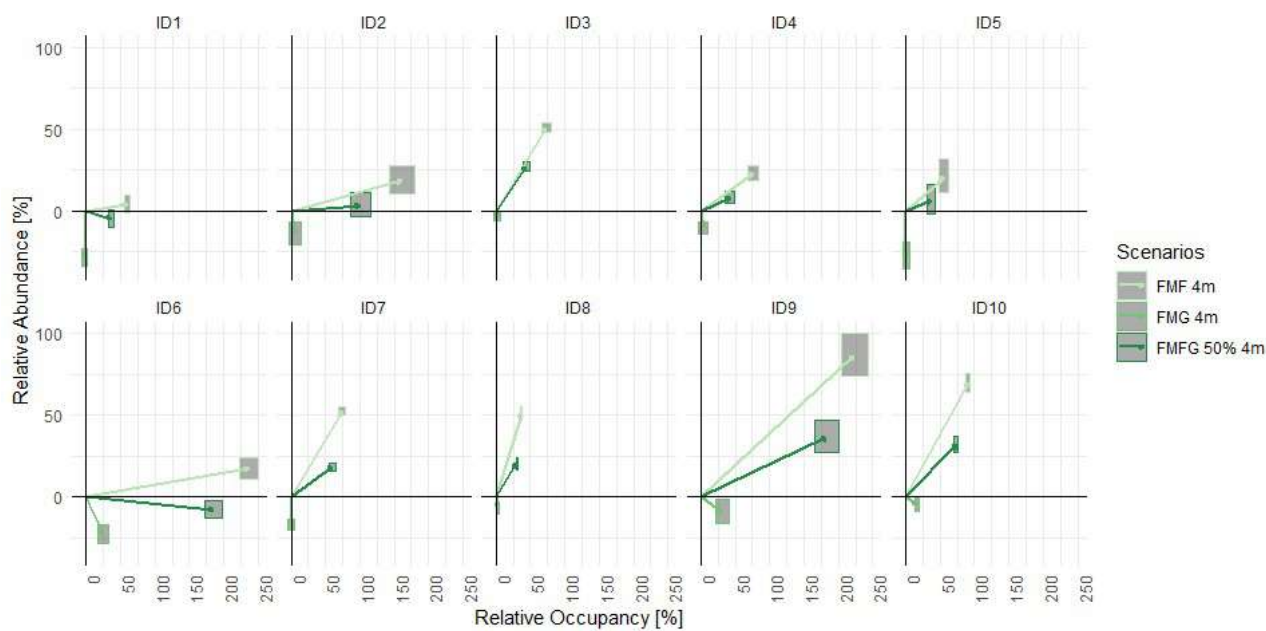


Figure 10.15 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes..

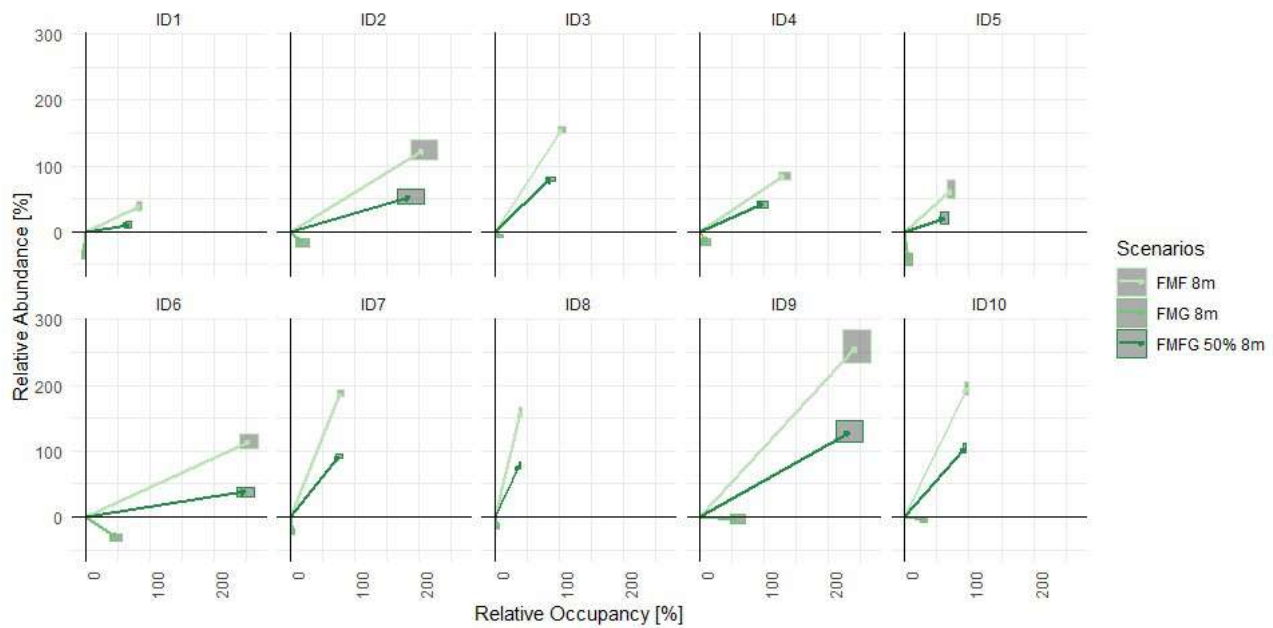


Figure 10.16 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.6 Setaside

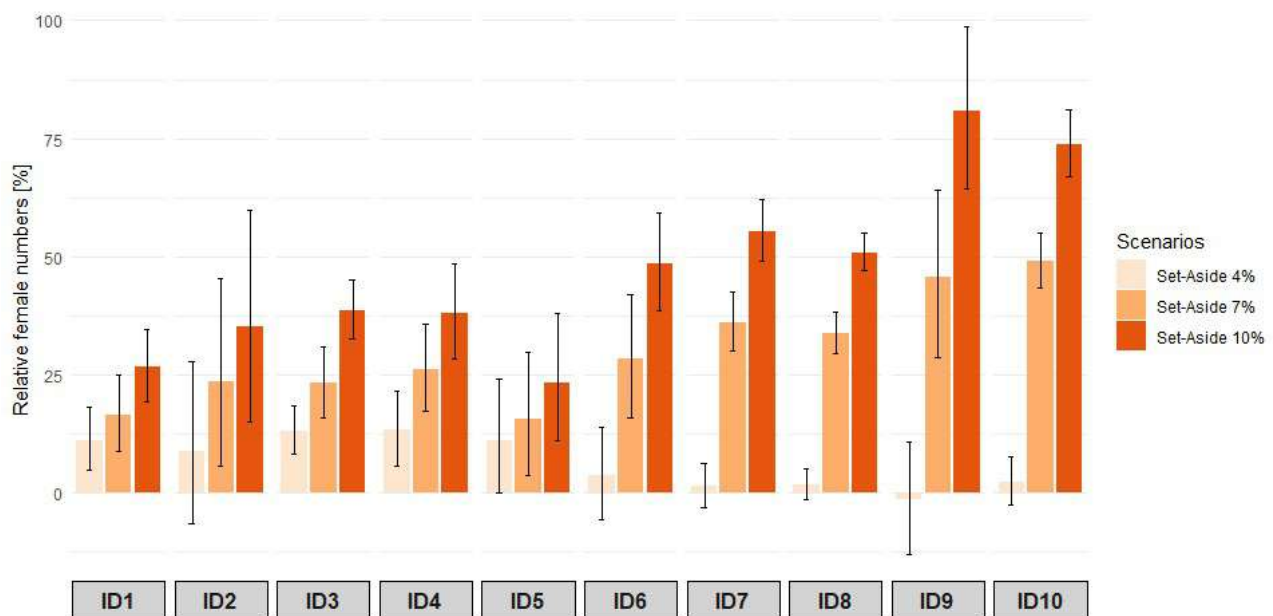


Figure 10.17 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

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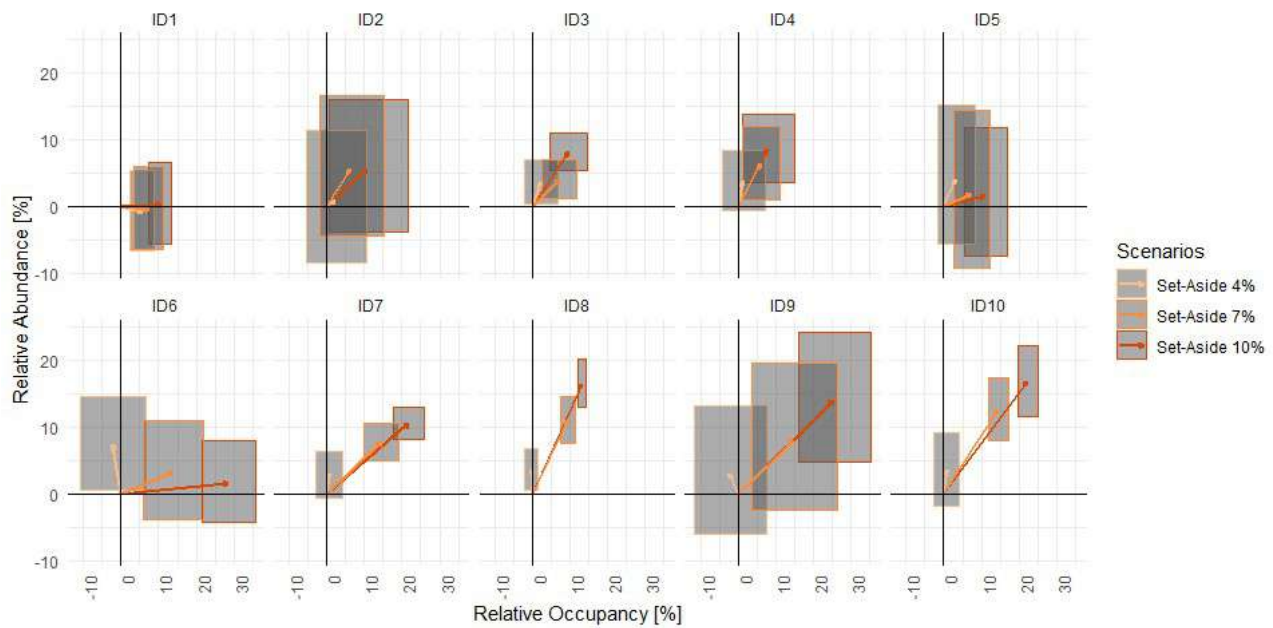


Figure 10.18 Setaside scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.7 Legume

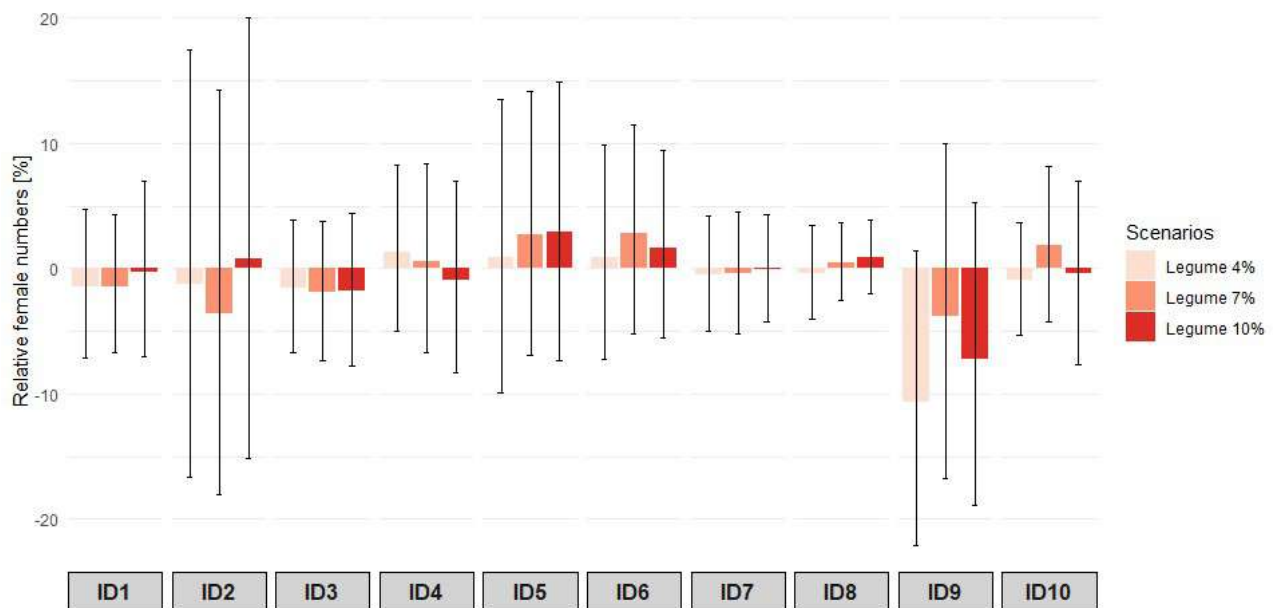


Figure 10.19 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

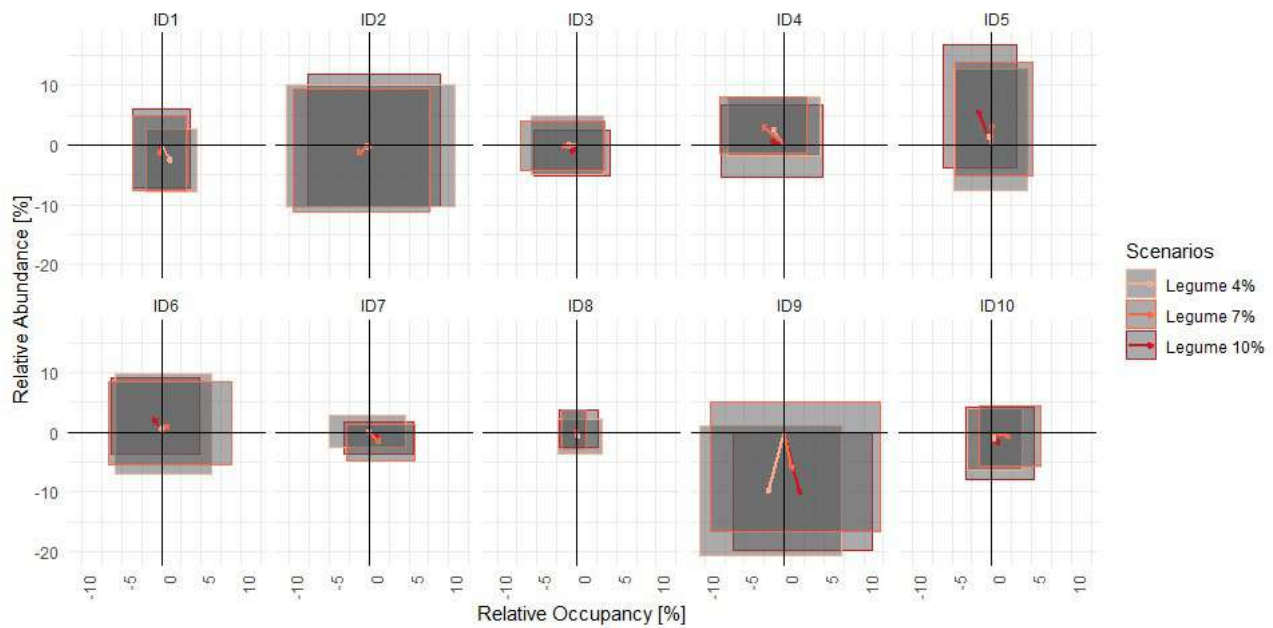


Figure 10.20 Legume scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.2.8 Biopesticides

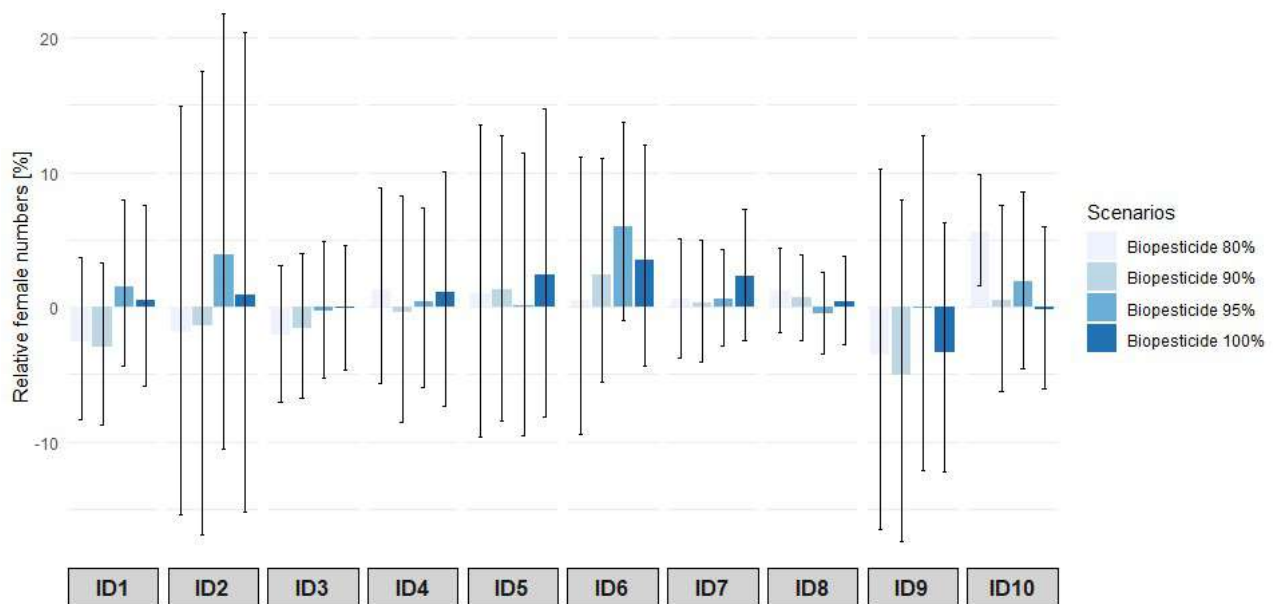


Figure 10.21 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Germany.

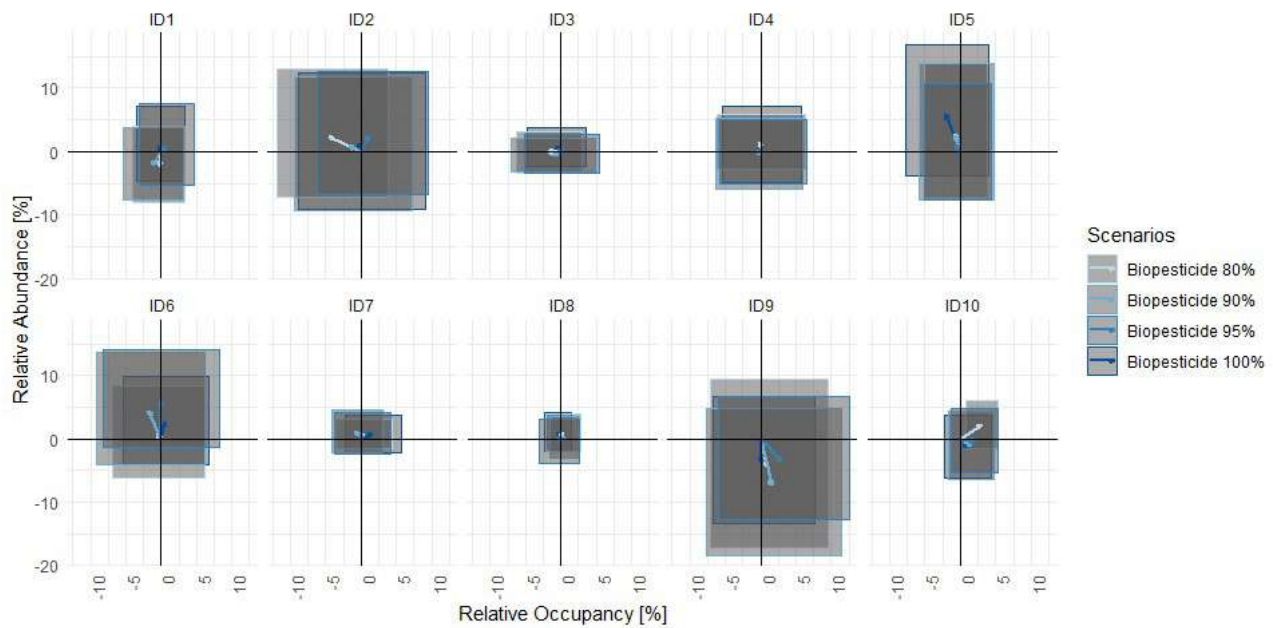


Figure 10.22 Biopesticide scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Germany at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3 Denmark

10.3.1 Crop diversification

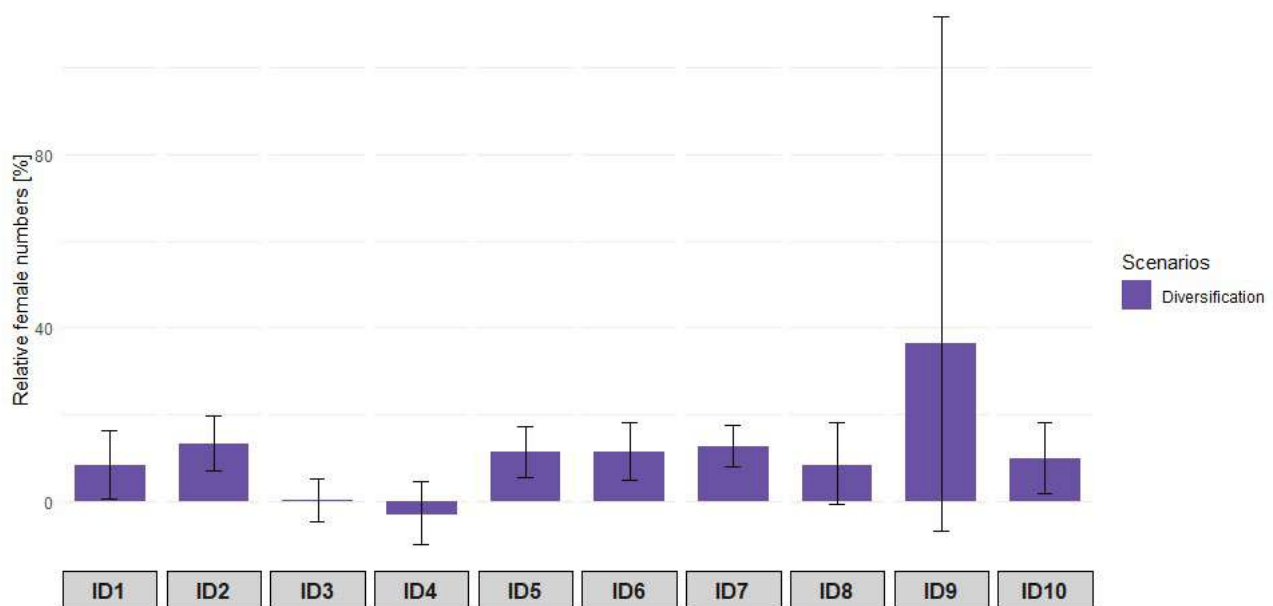


Figure 10.23 Diversification scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

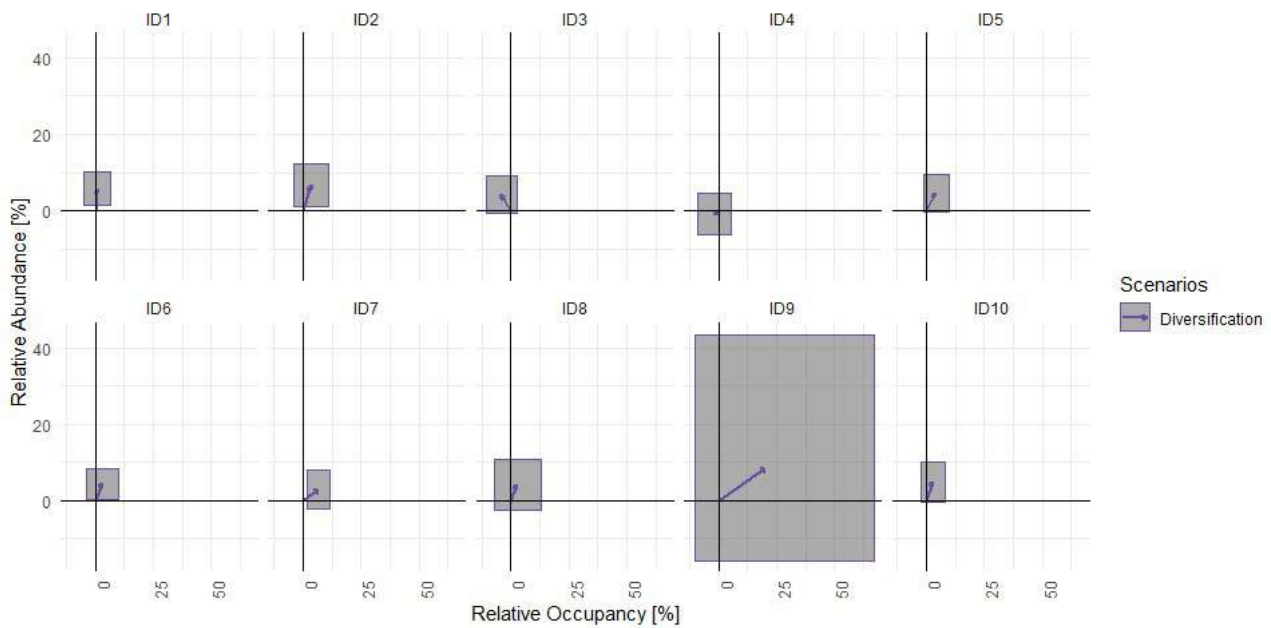


Figure 10.24 Diversification scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.2 Flower field margins

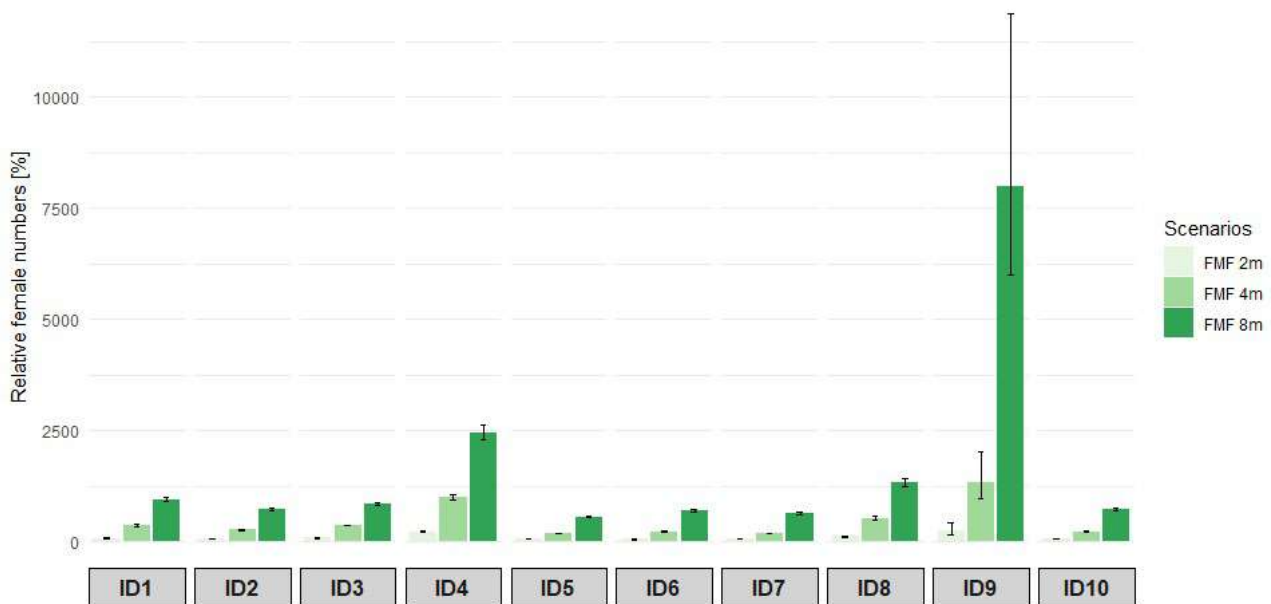


Figure 10.25 Flower field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

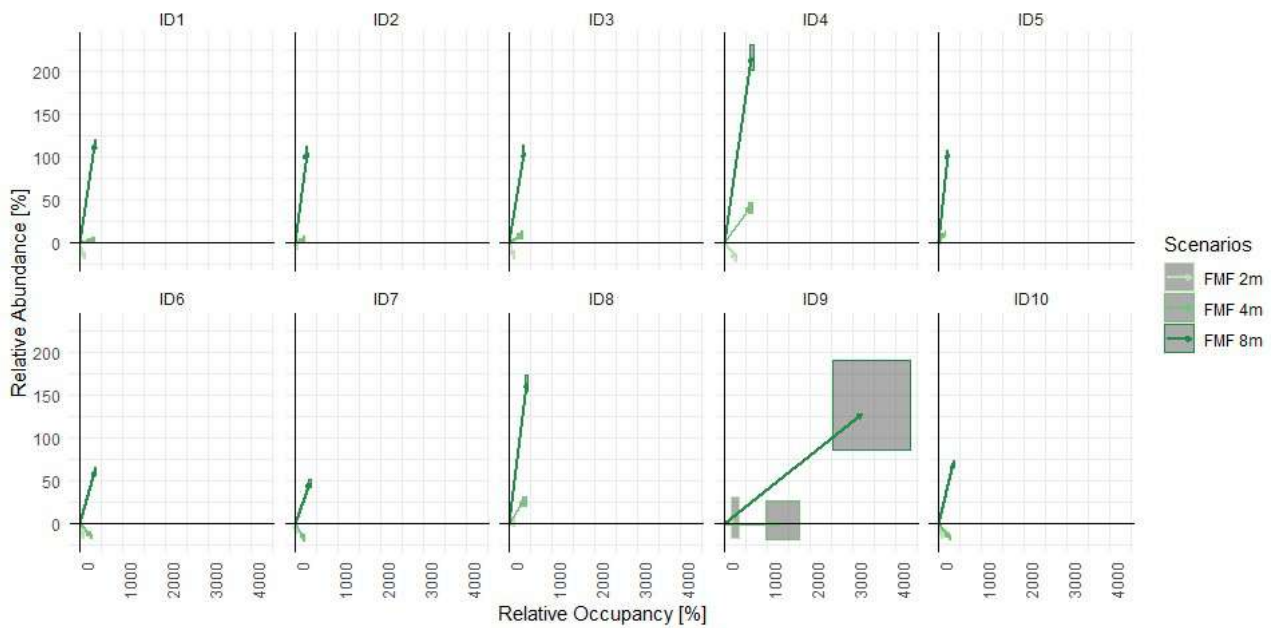


Figure 10.26 Flower field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.3 Grassy field margins

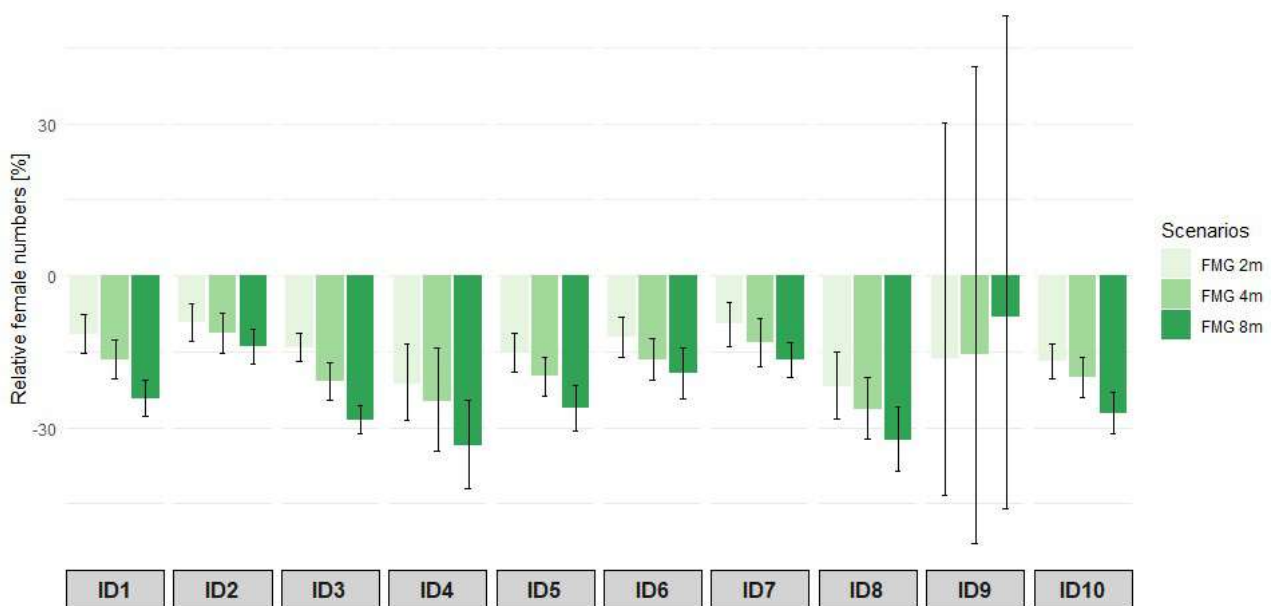


Figure 10.27 Grassy field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

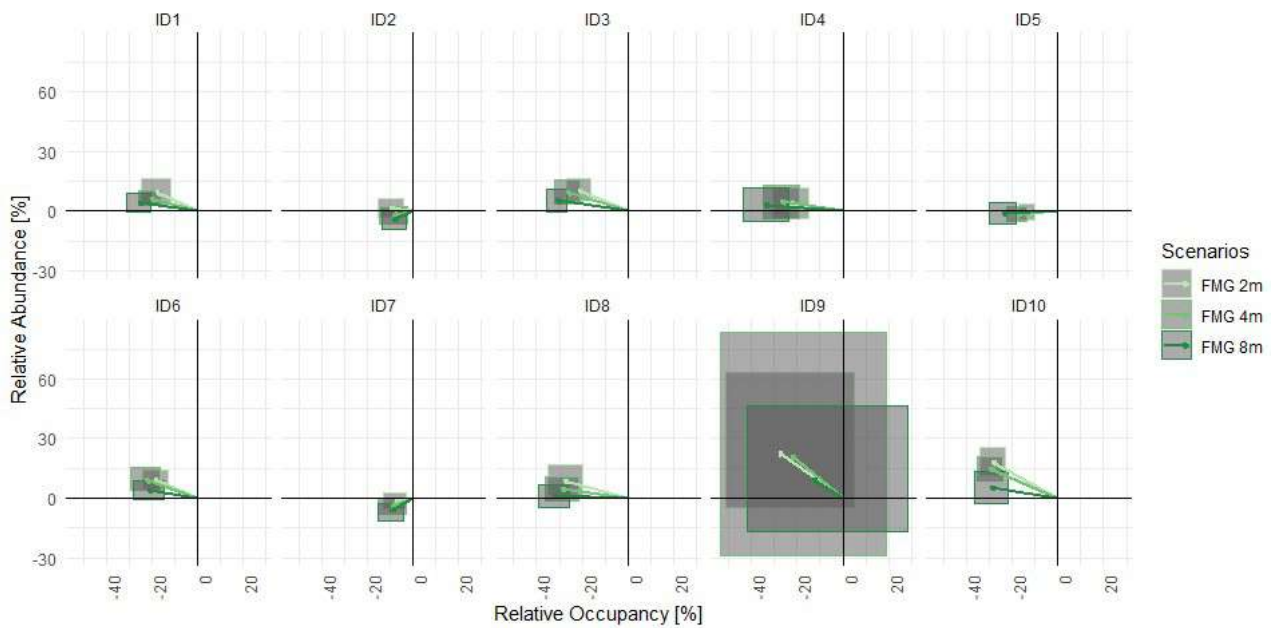


Figure 10.28 Grassy field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.4 Mixed field margins

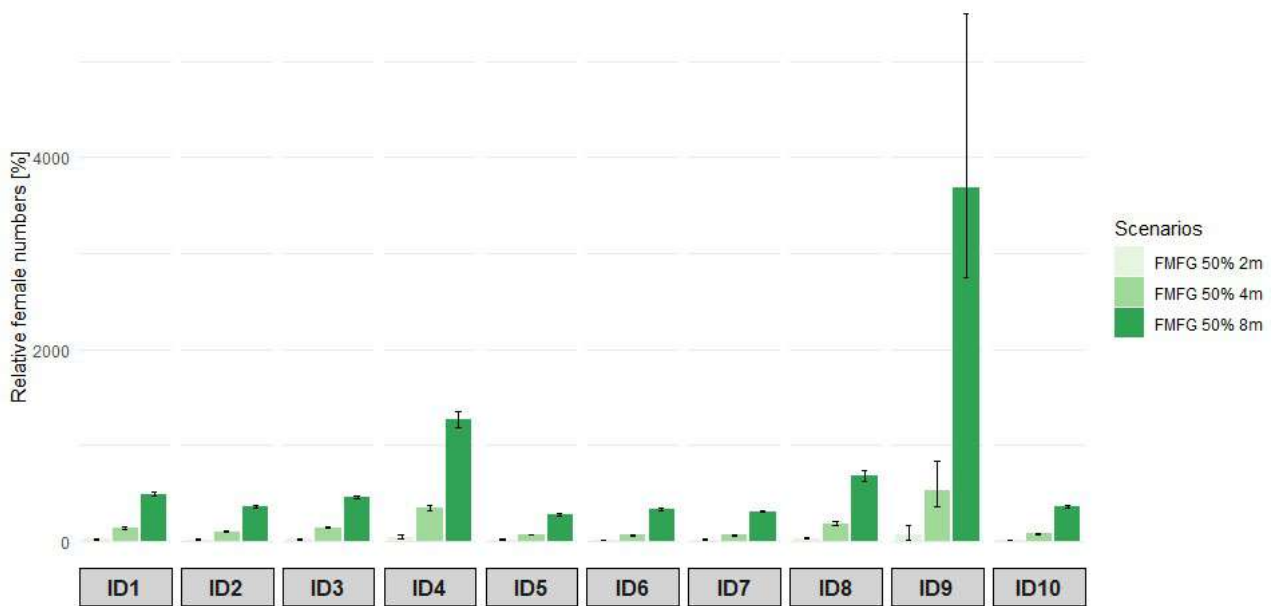


Figure 10.29 Mixed field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

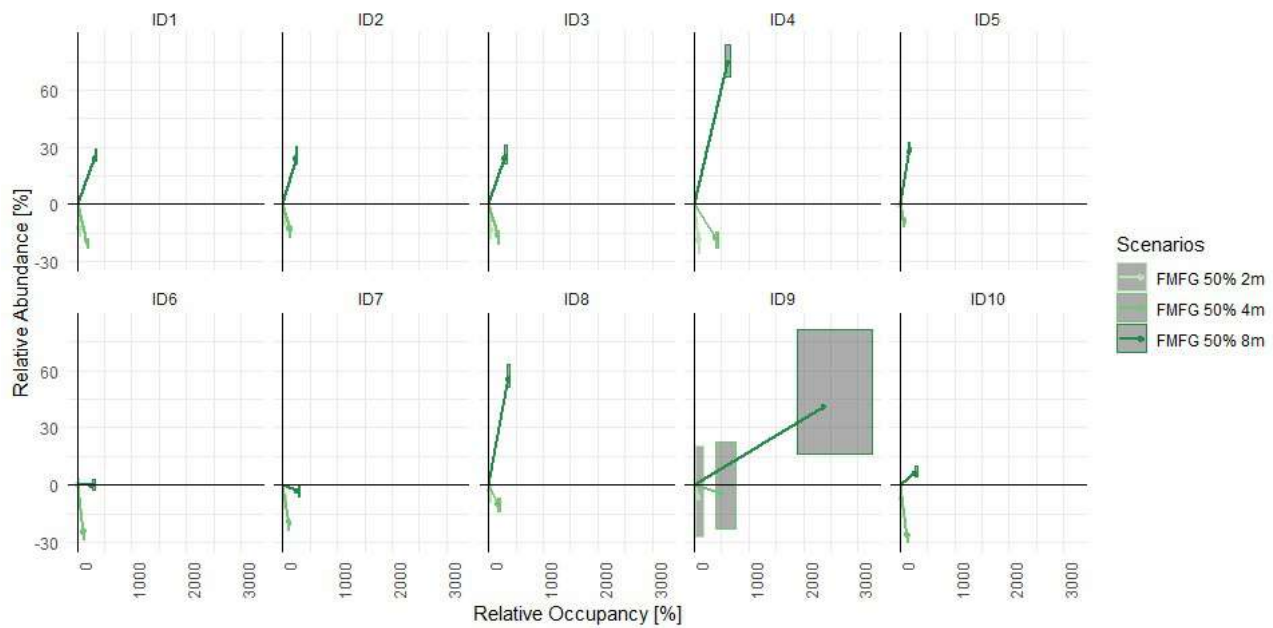


Figure 10.30 Mixed field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.5 Flower, grassy and mixed field margins

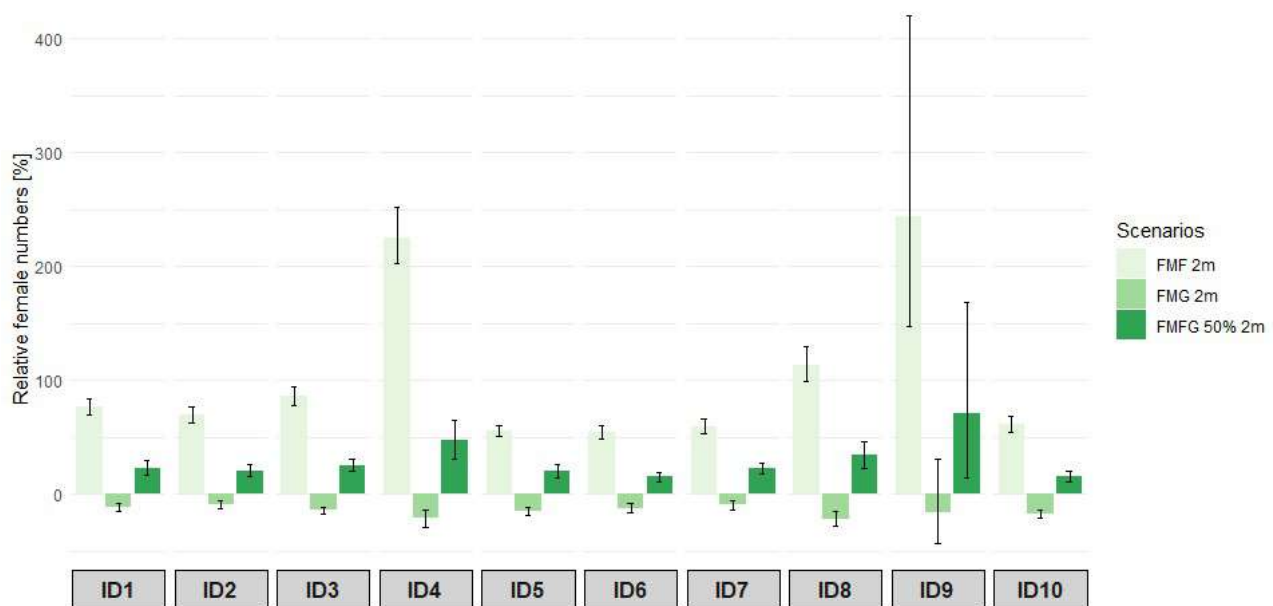


Figure 10.31 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

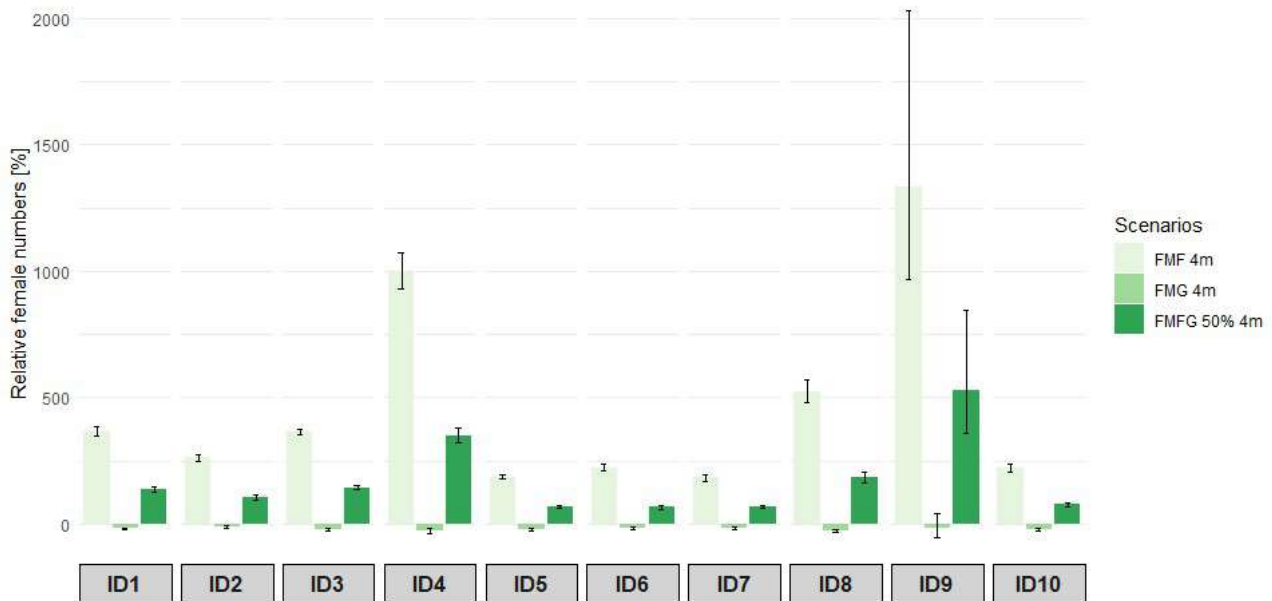


Figure 10.32 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

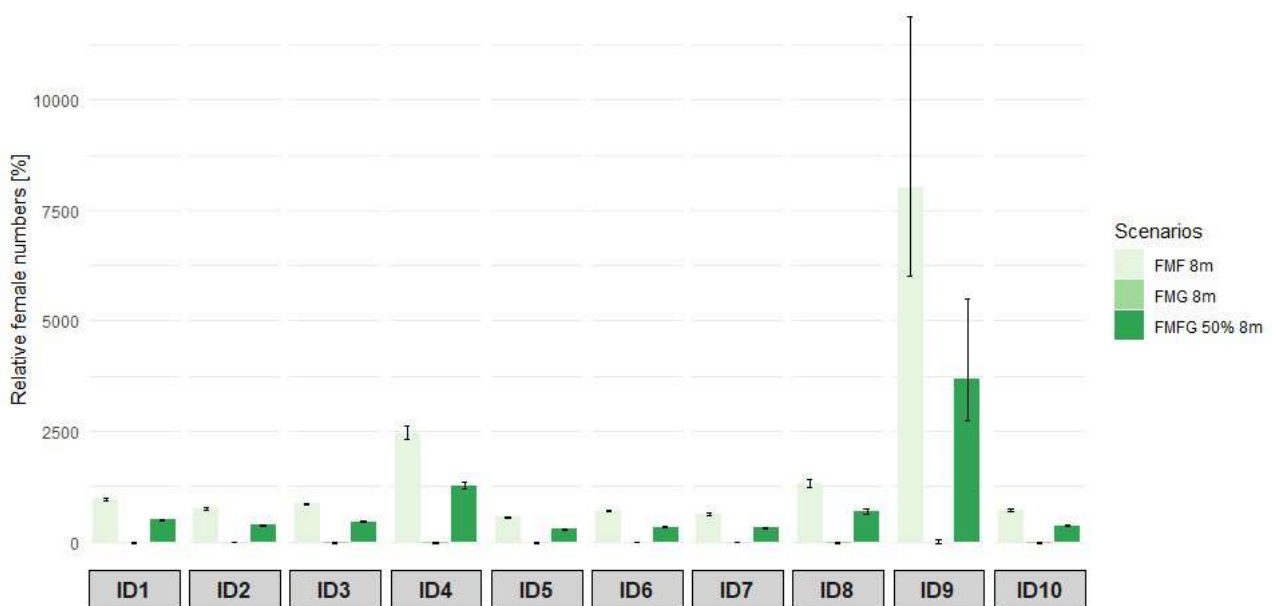


Figure 10.33 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

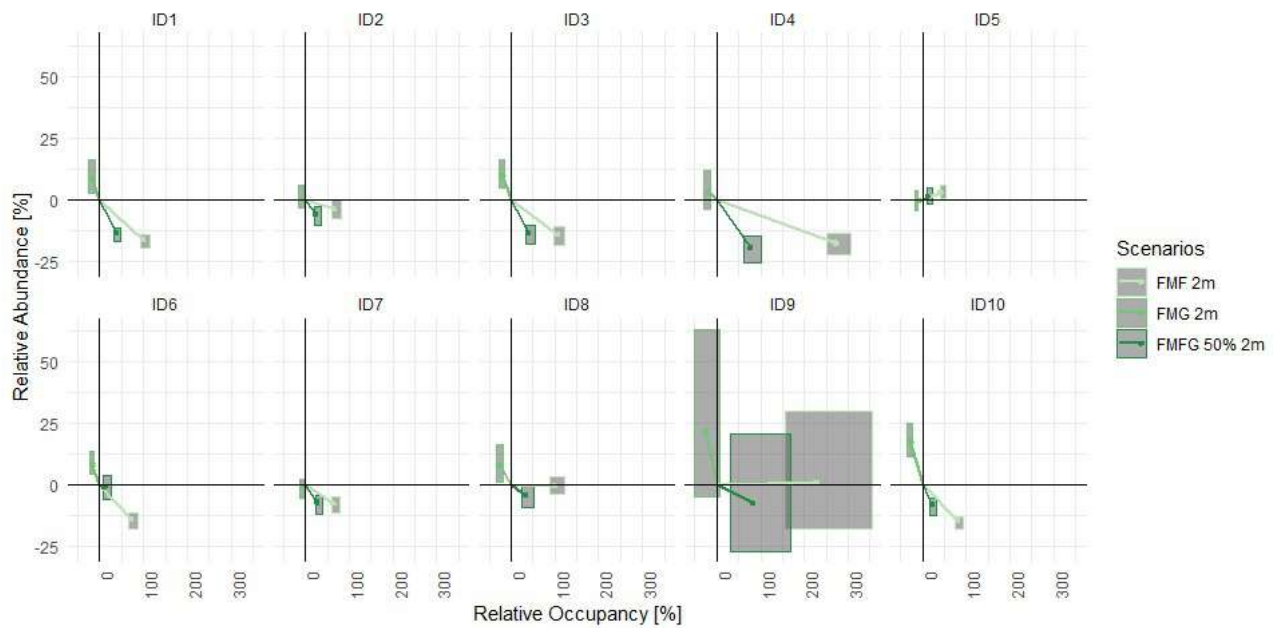


Figure 10.34 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

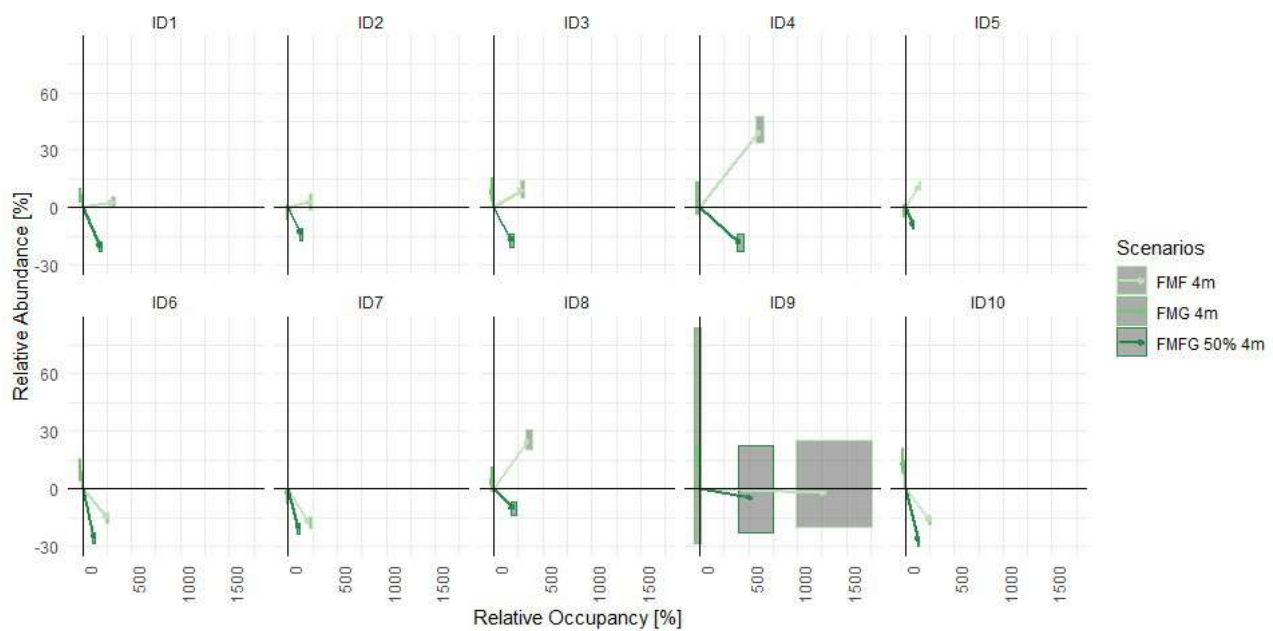


Figure 10.35 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes..

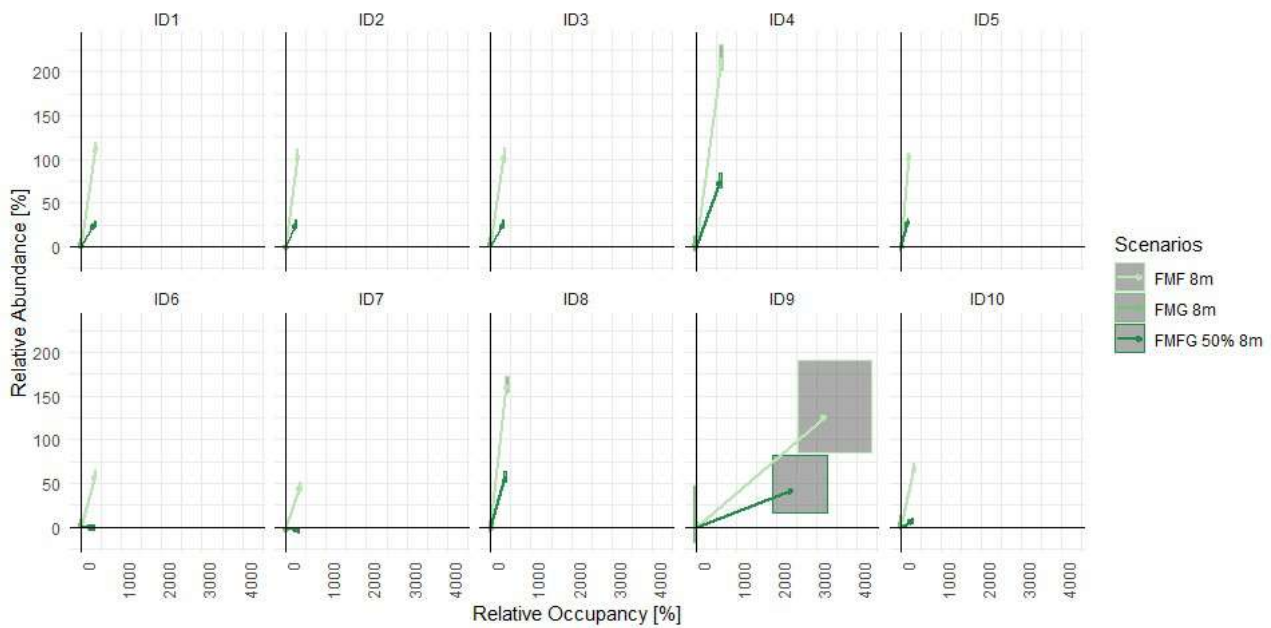


Figure 10.36 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.6 Setaside

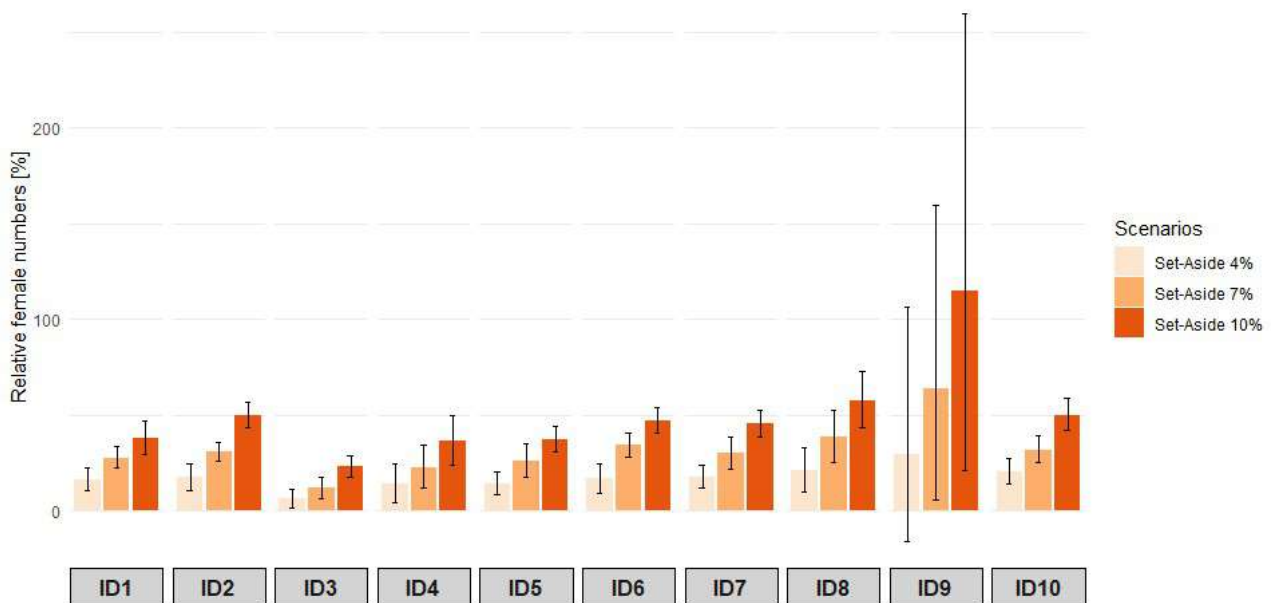


Figure 10.37 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

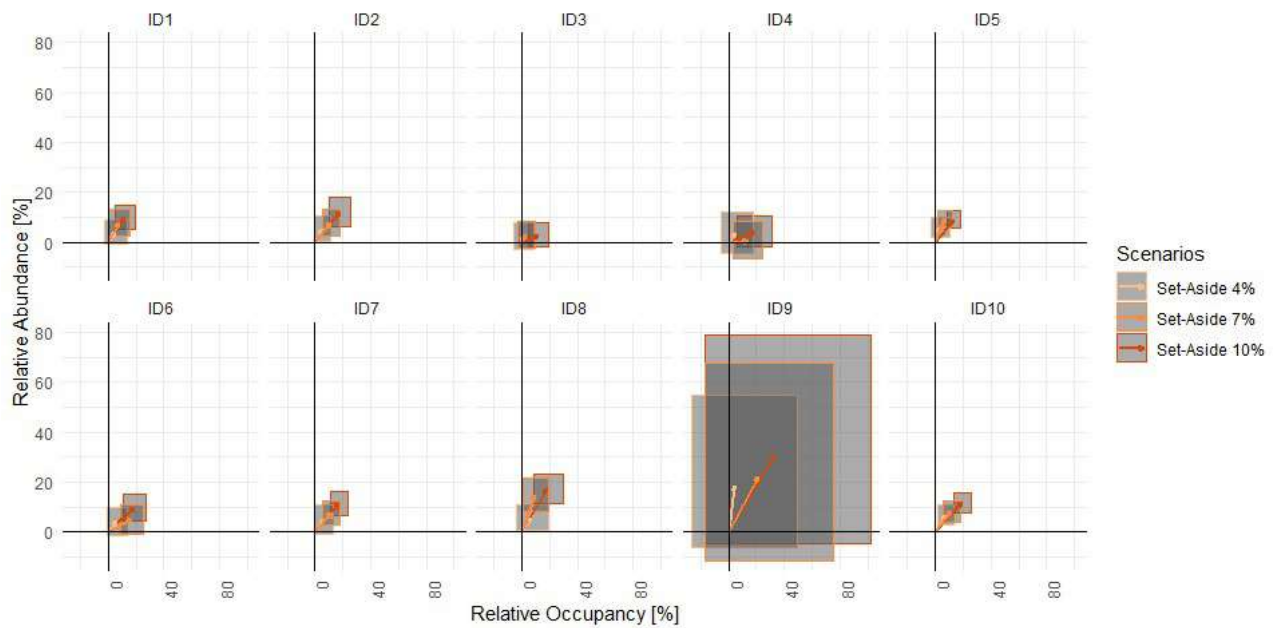


Figure 10.38 Setaside scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.7 Legume



Figure 10.39 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

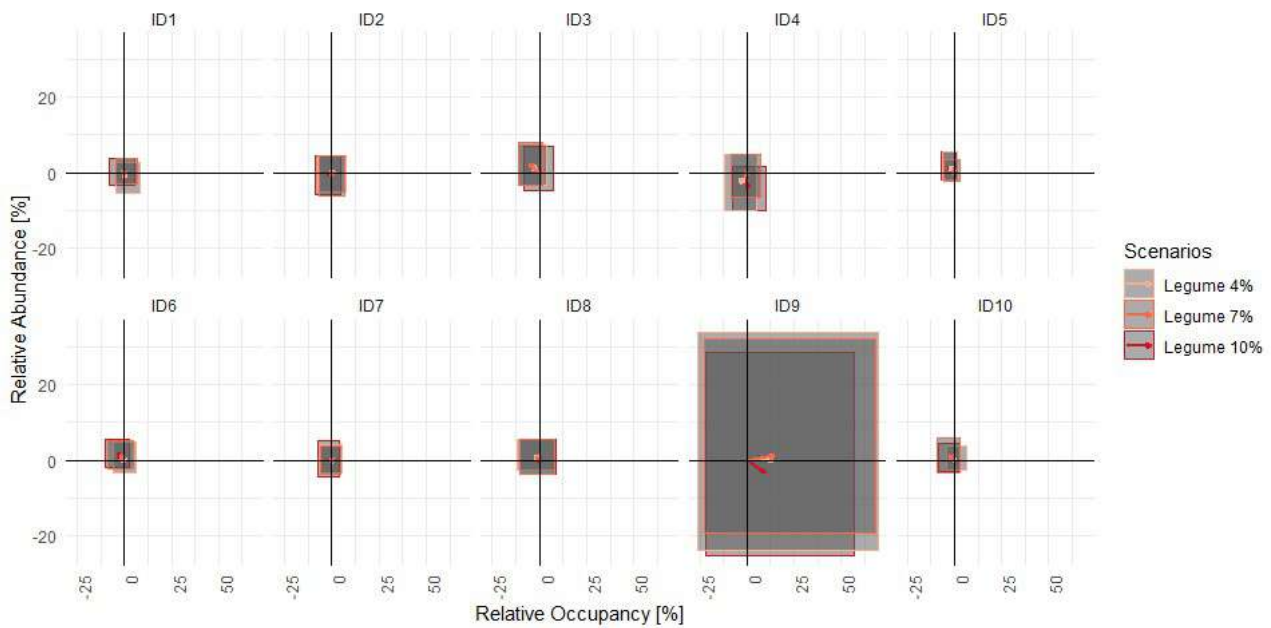


Figure 10.40 Legume scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.3.8 Biopesticides

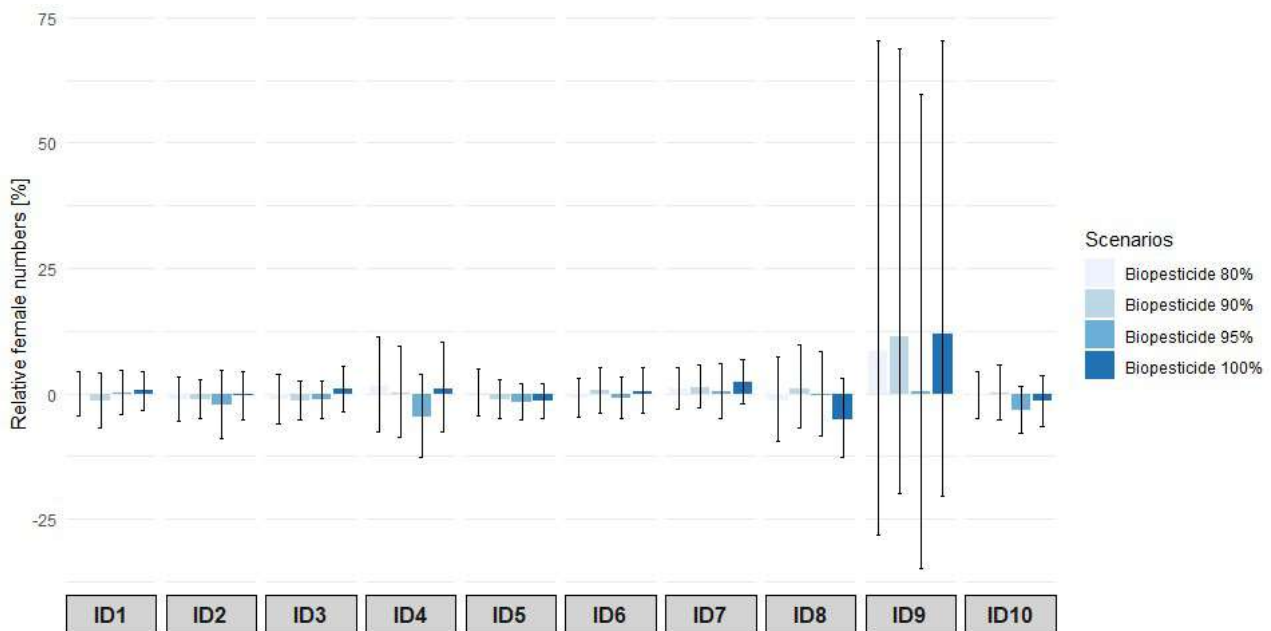


Figure 10.41 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Denmark.

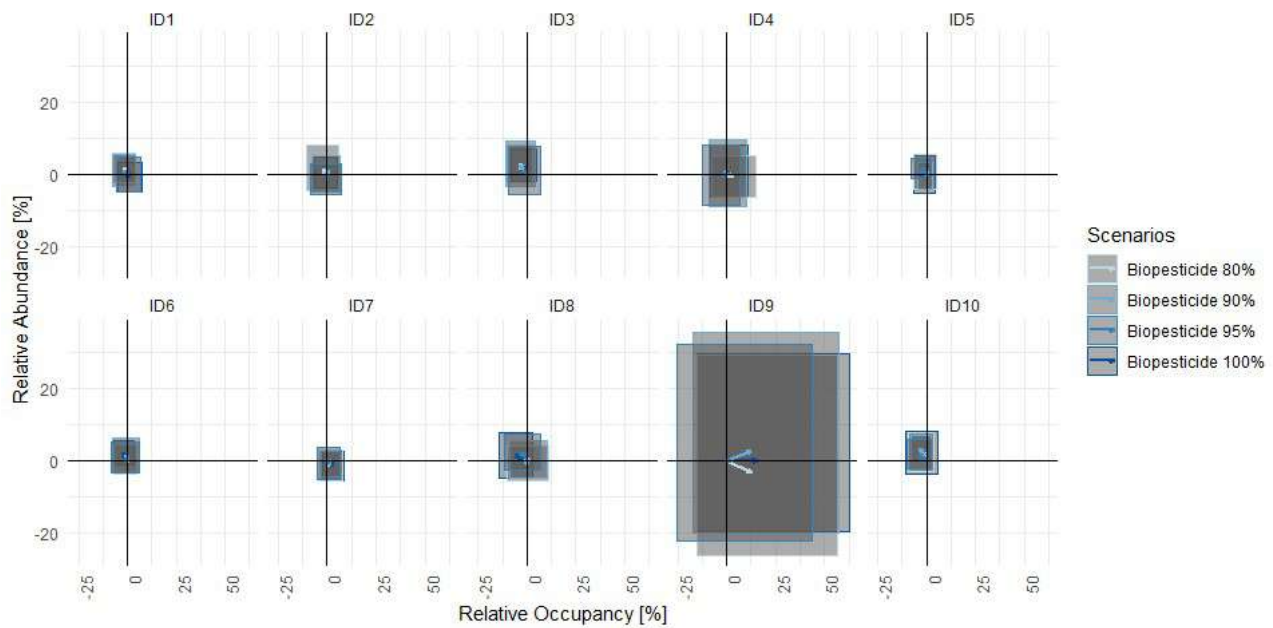


Figure 10.42 Biopesticide scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Denmark at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4 Poland

10.4.1 Flower field margins

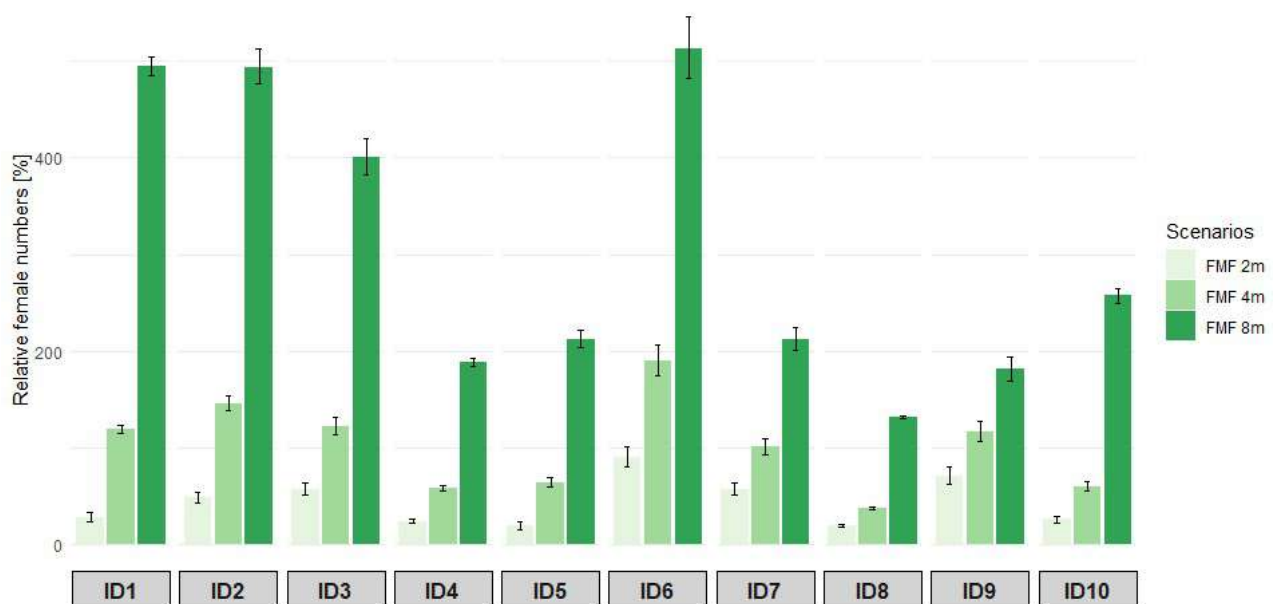


Figure 10.43 Flower field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

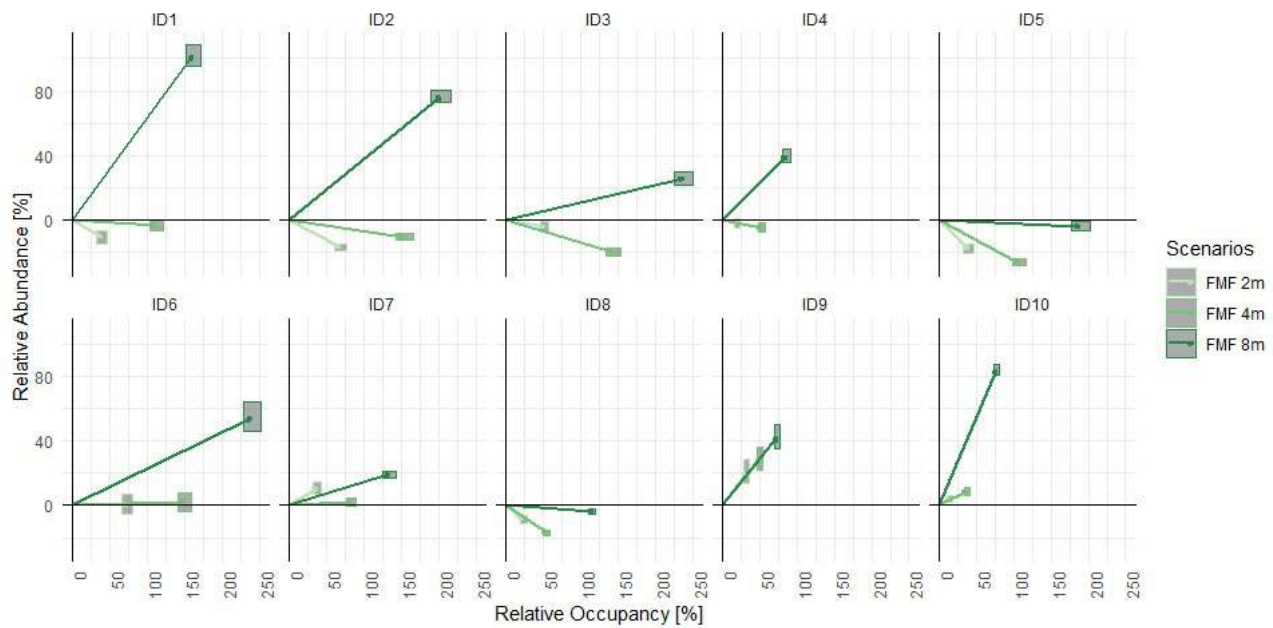


Figure 10.44 Flower field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4.2 Grassy field margins

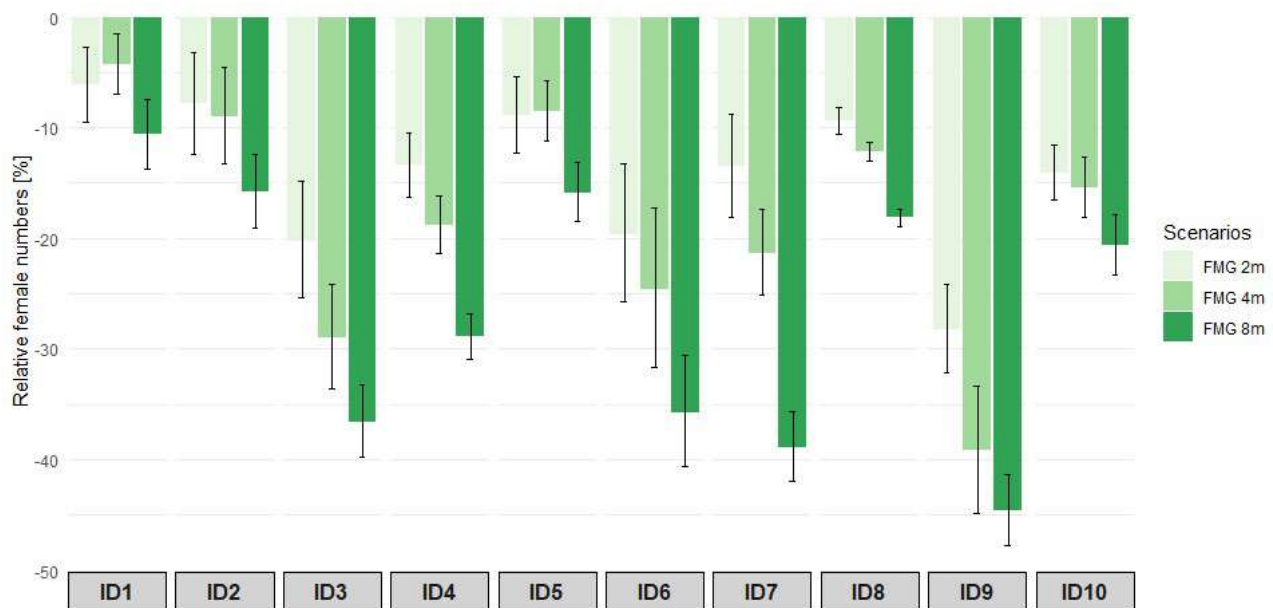


Figure 10.45 Grassy field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

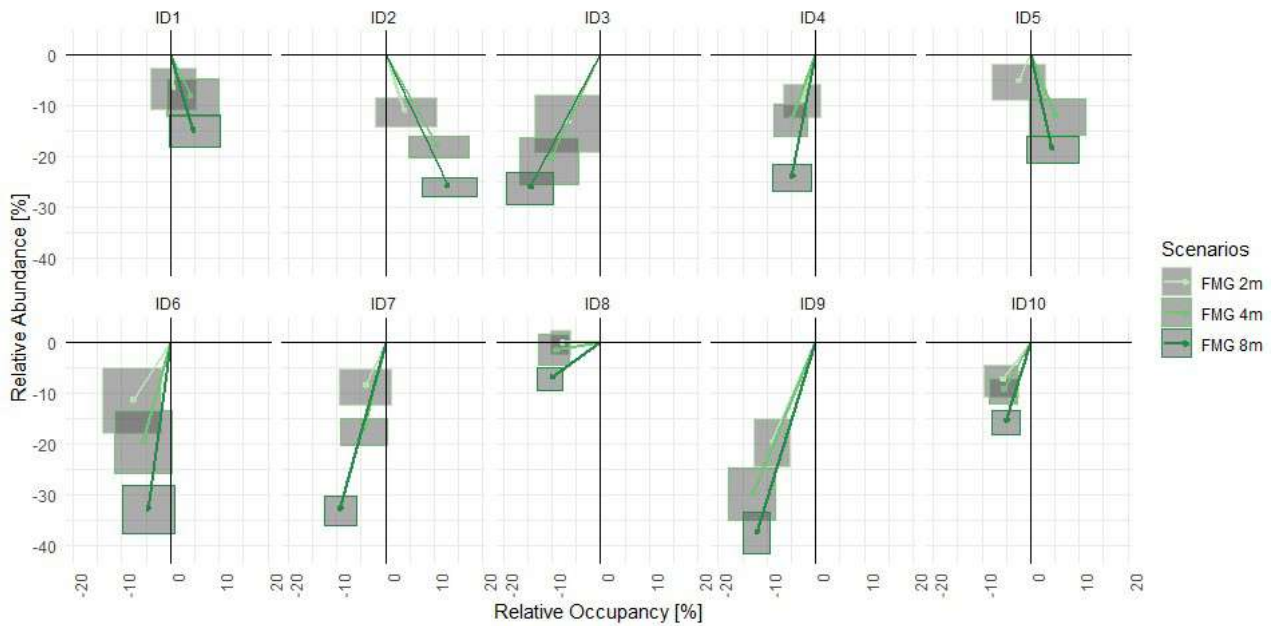


Figure 10.46 Grassy field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4.3 Mixed field margins

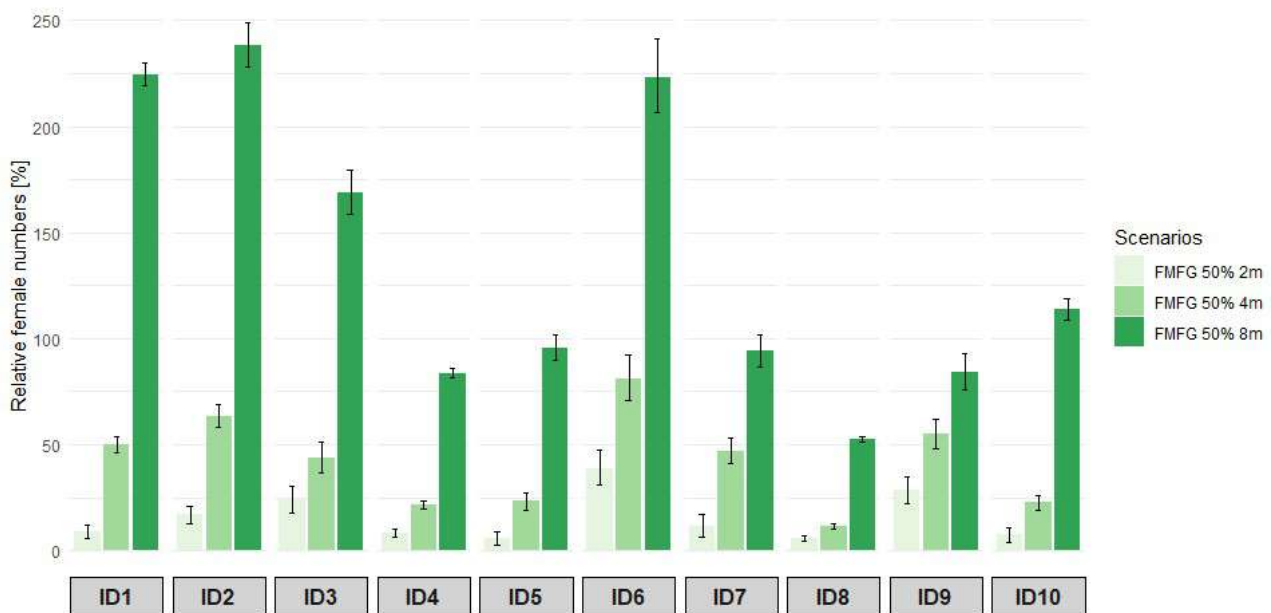


Figure 10.47 Mixed field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

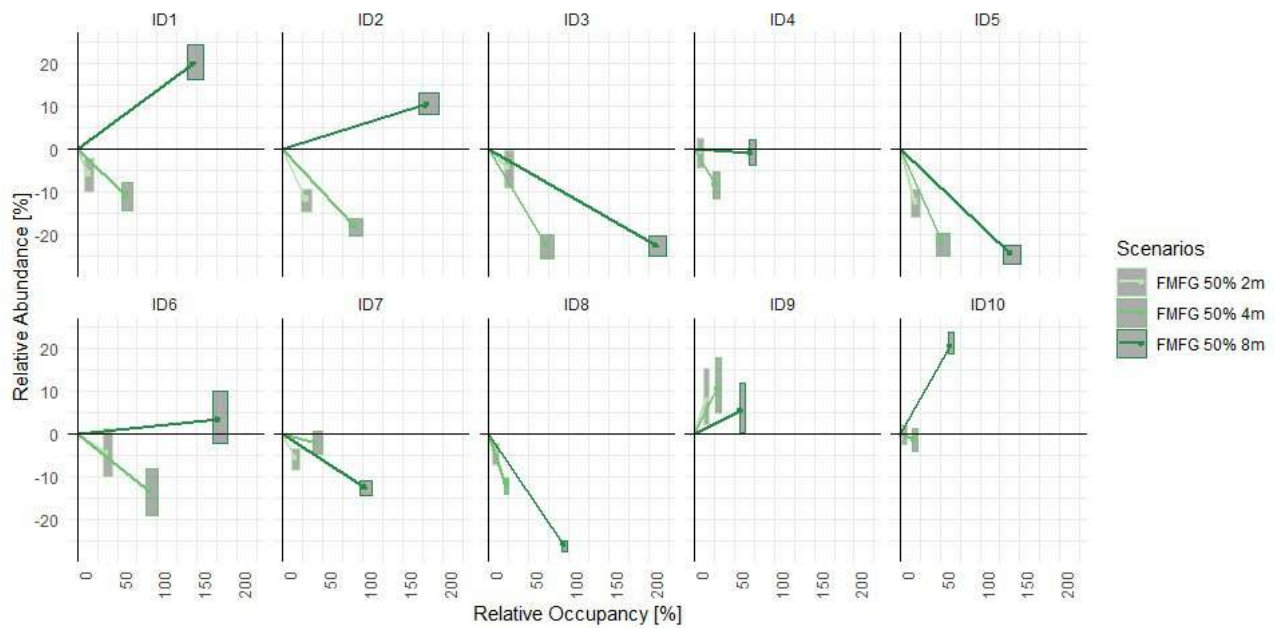


Figure 10.48 Mixed field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4.4 Flower, grassy and mixed field margins

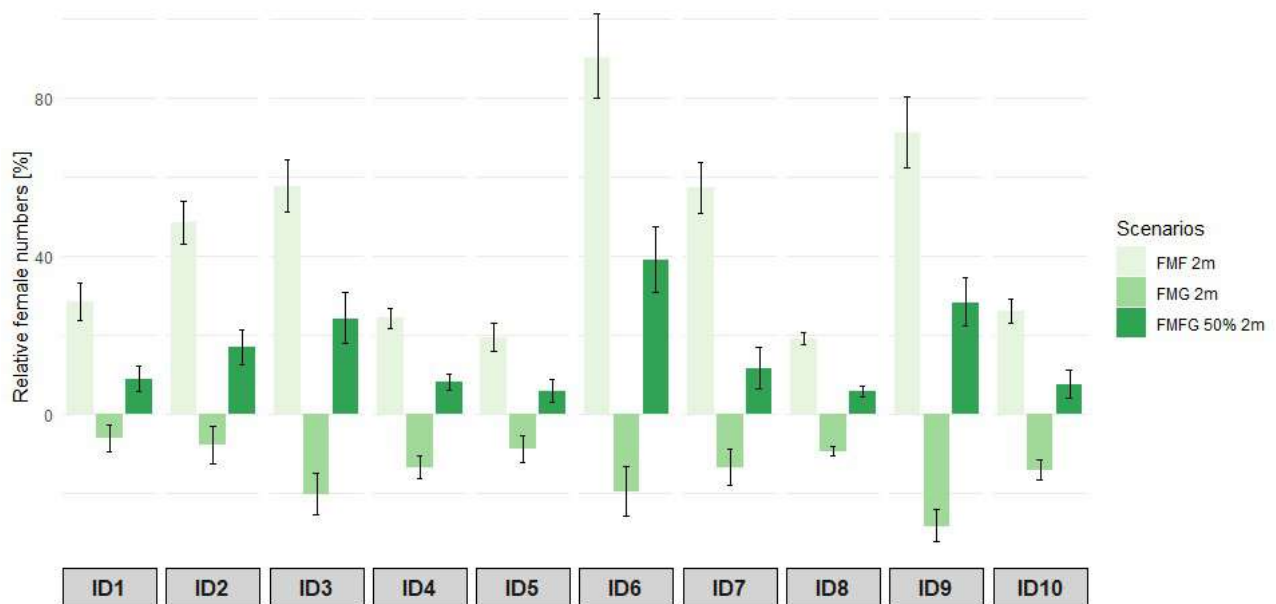


Figure 10.49 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

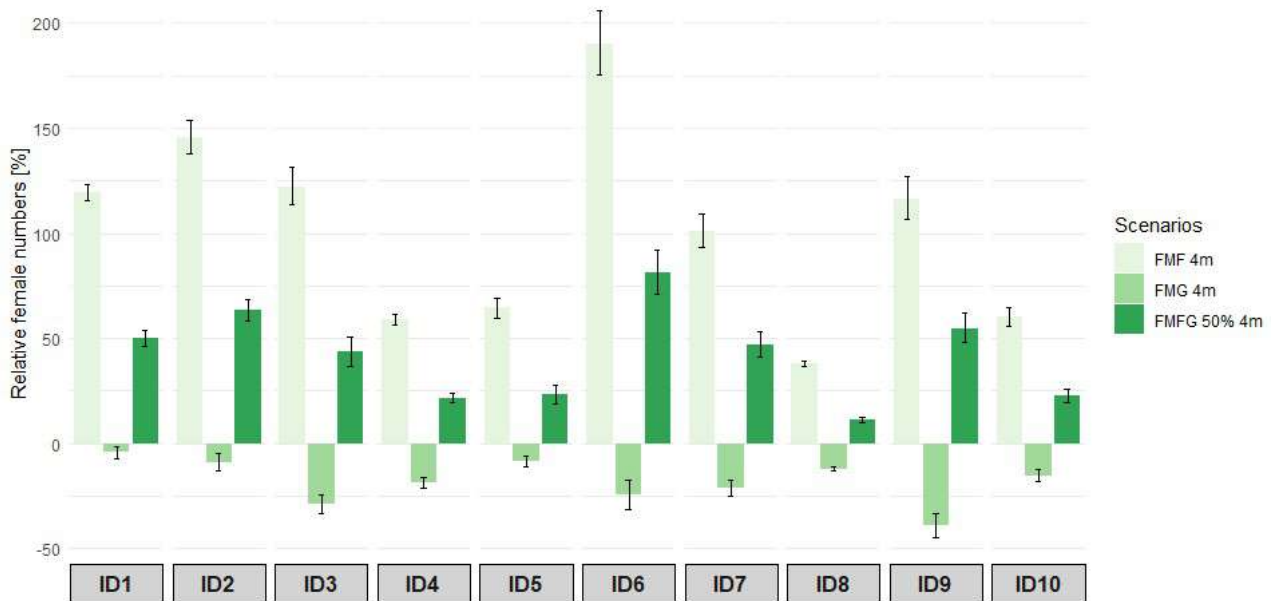


Figure 10.50 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

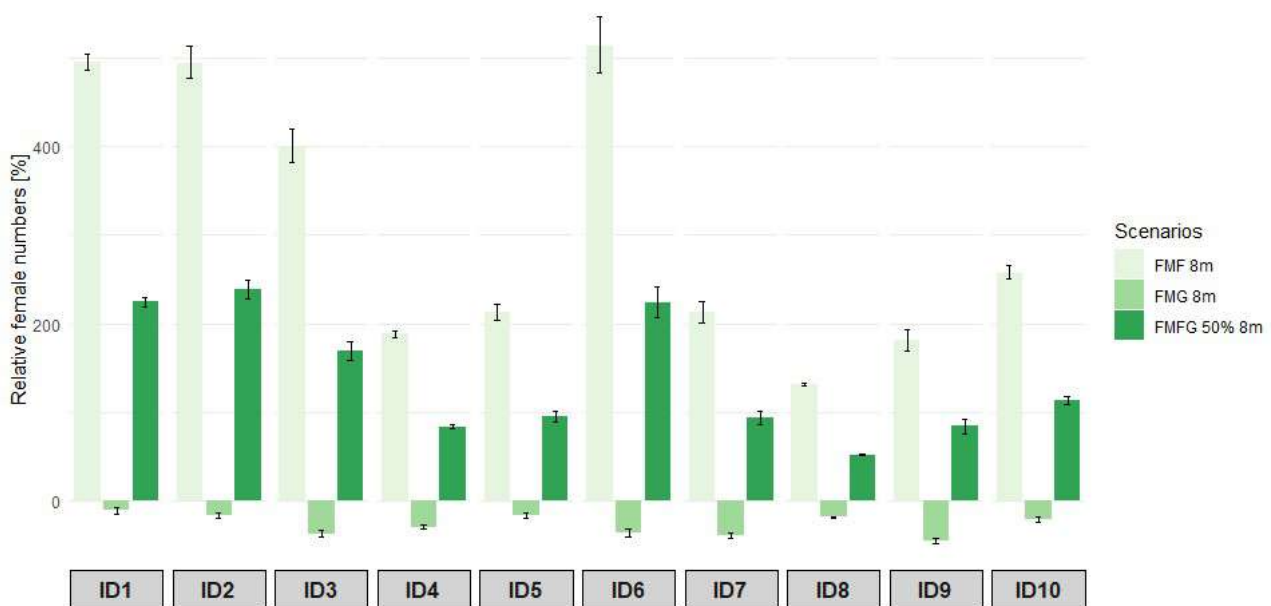


Figure 10.51 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

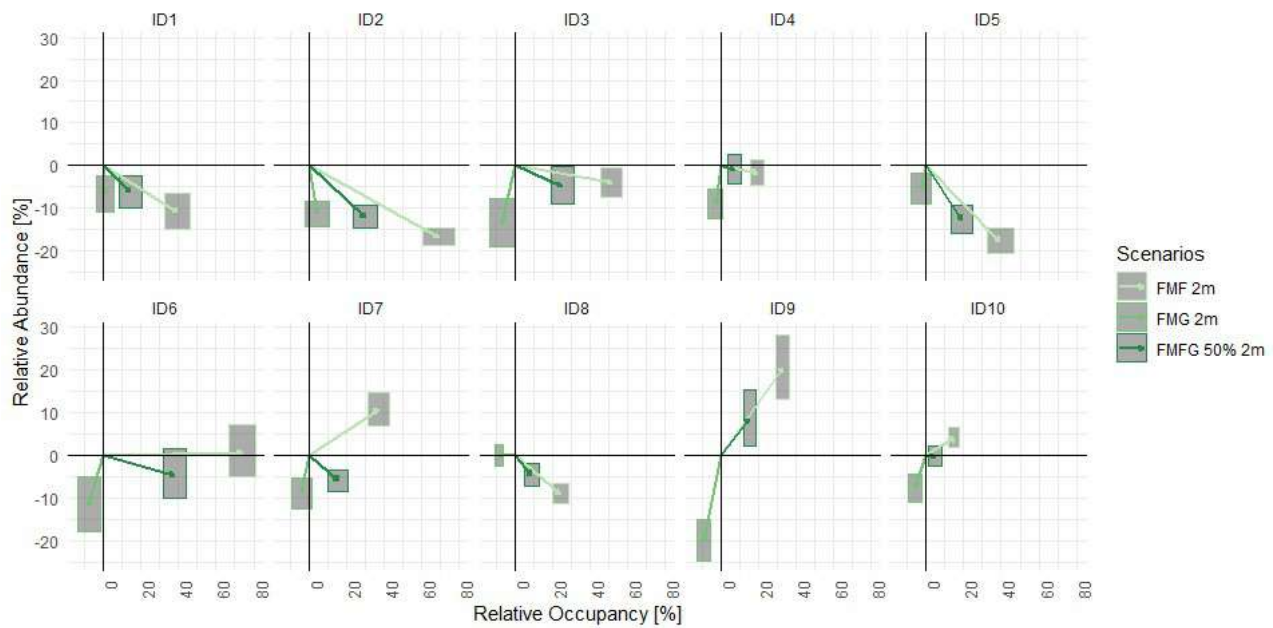


Figure 10.52 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

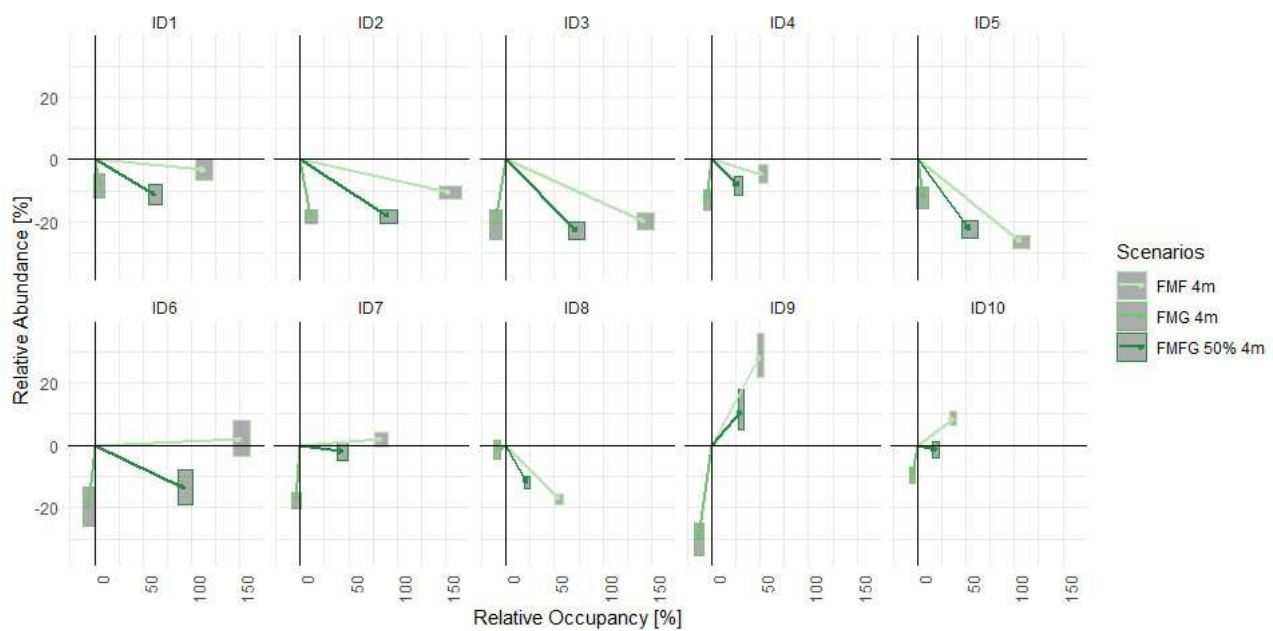


Figure 10.53 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes..

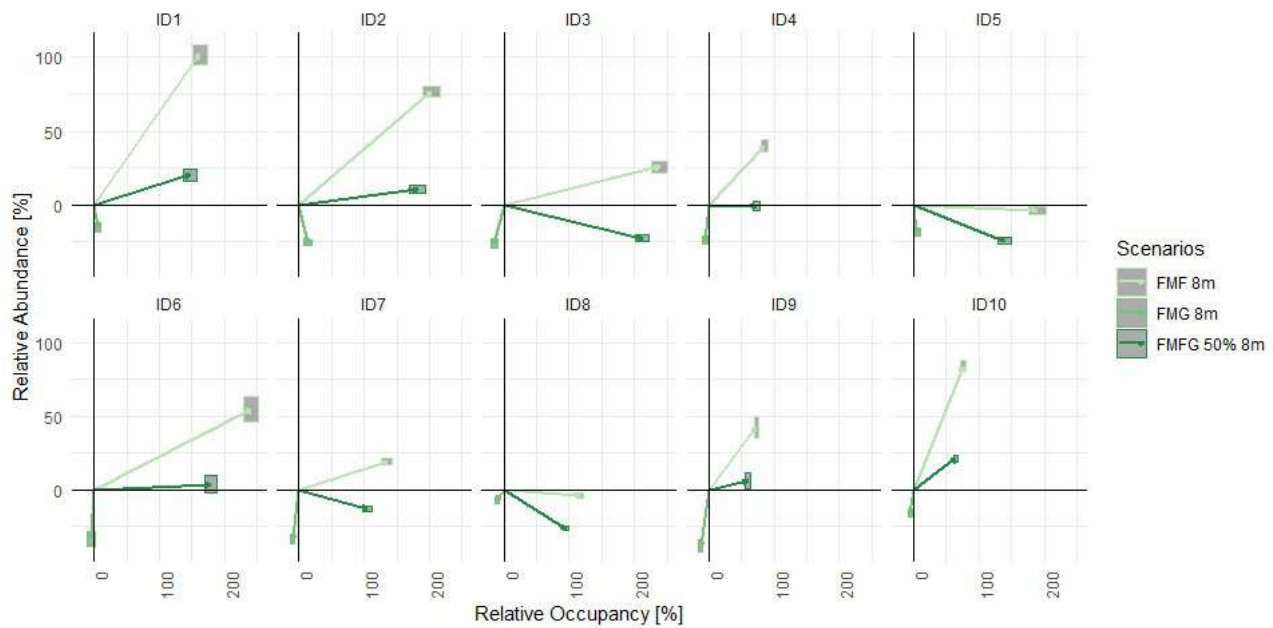


Figure 10.54 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4.5 Setaside

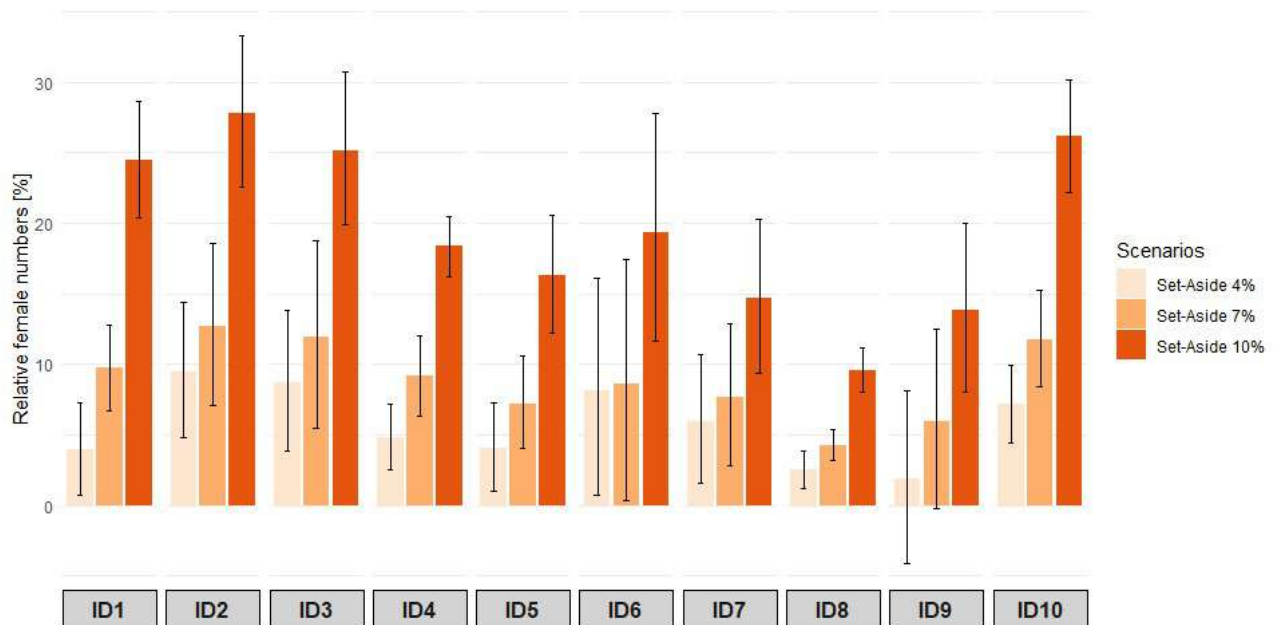


Figure 10.55 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

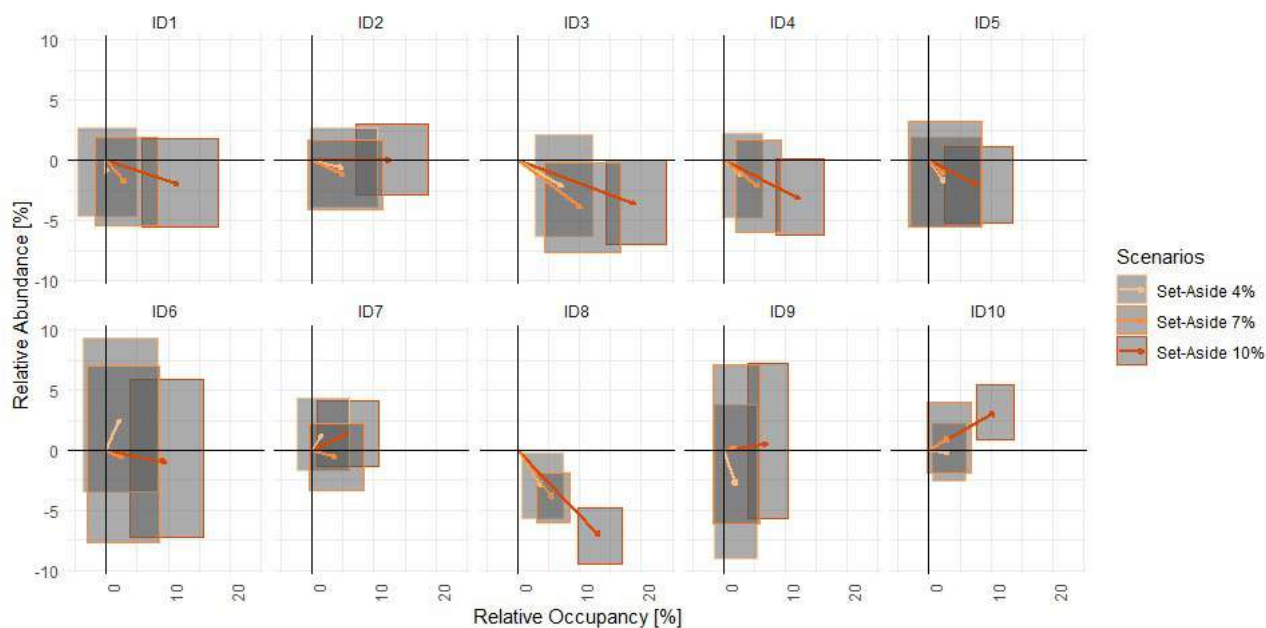


Figure 10.56 Setaside scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4.6 Legume

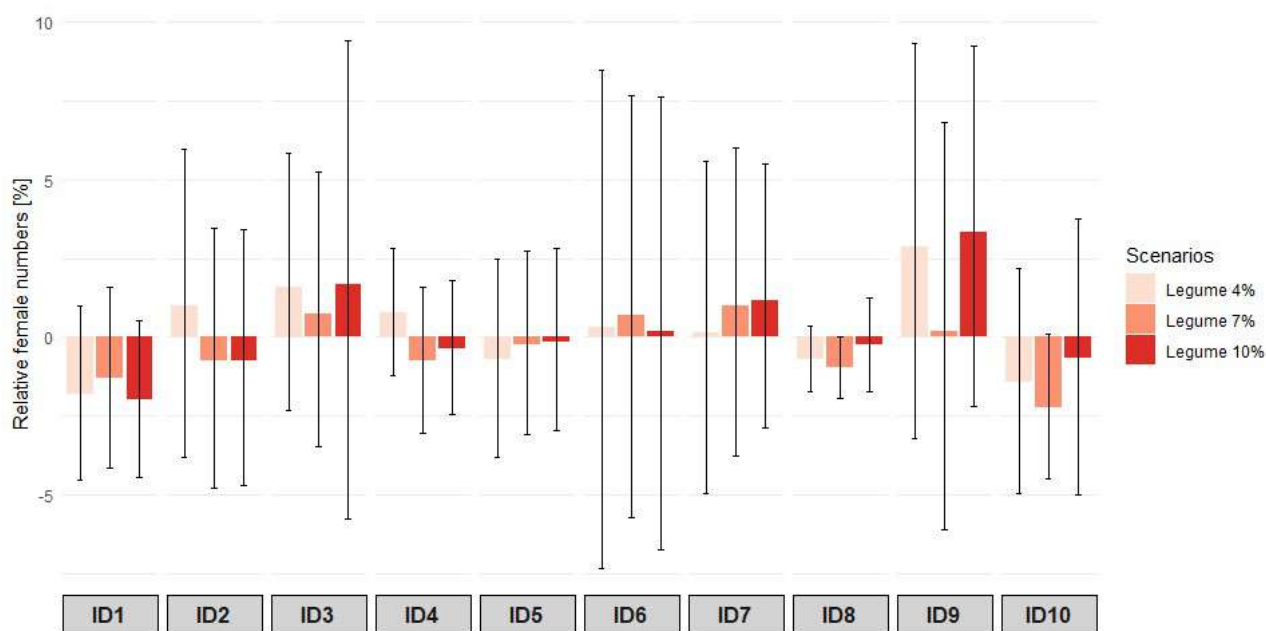


Figure 10.57 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

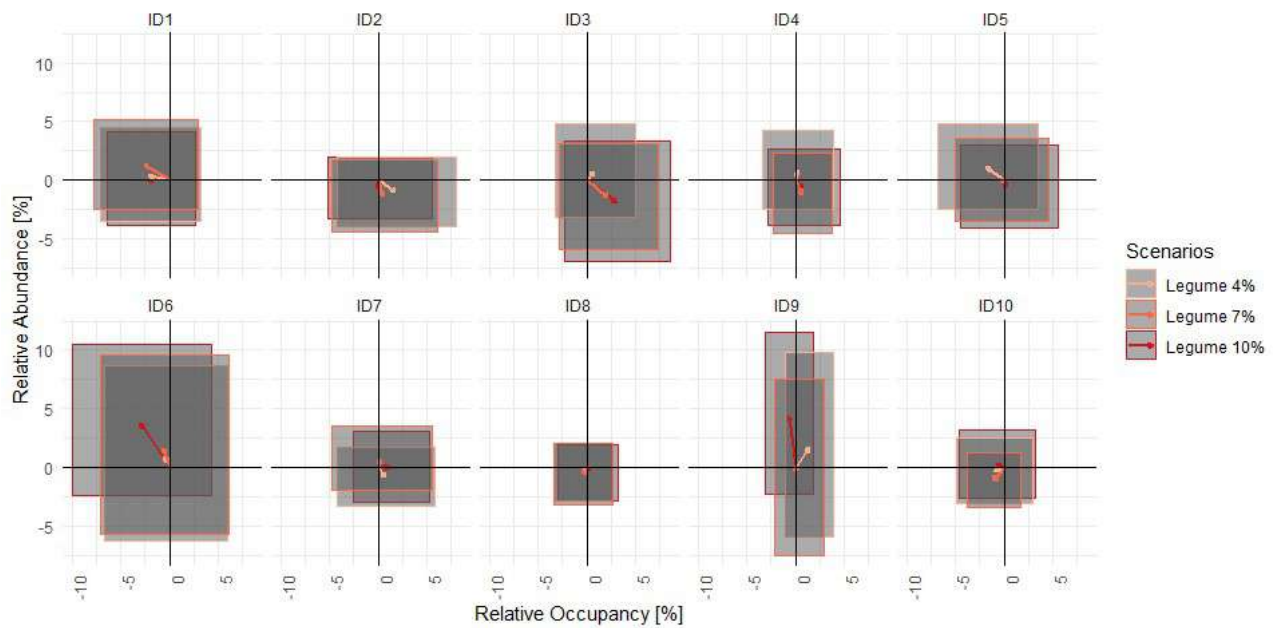


Figure 10.58 Legume scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.4.7 Biopesticides

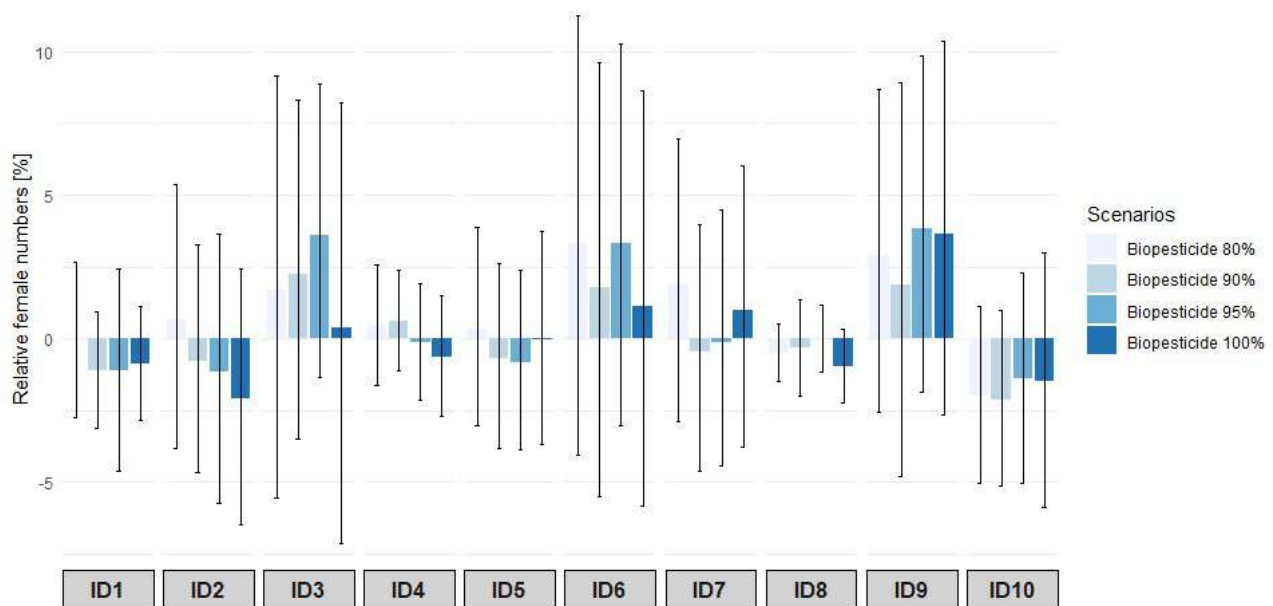


Figure 10.59 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Poland.

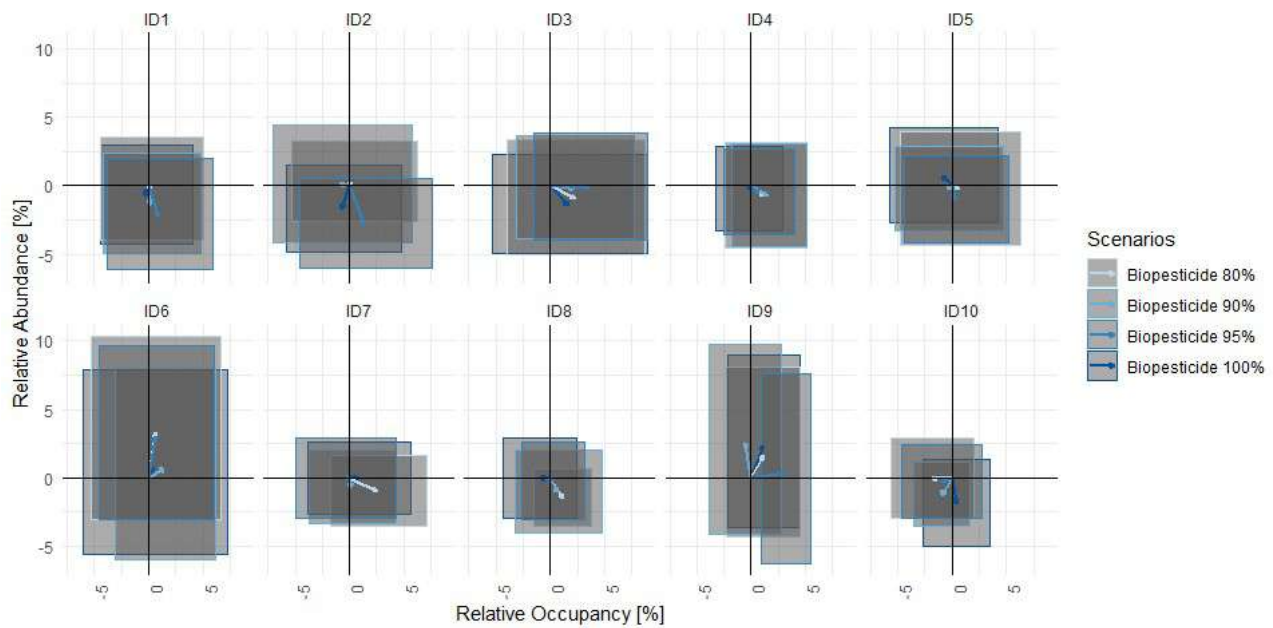


Figure 10.60 Biopesticide scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Poland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5 Finland

10.5.1 Flower field margins

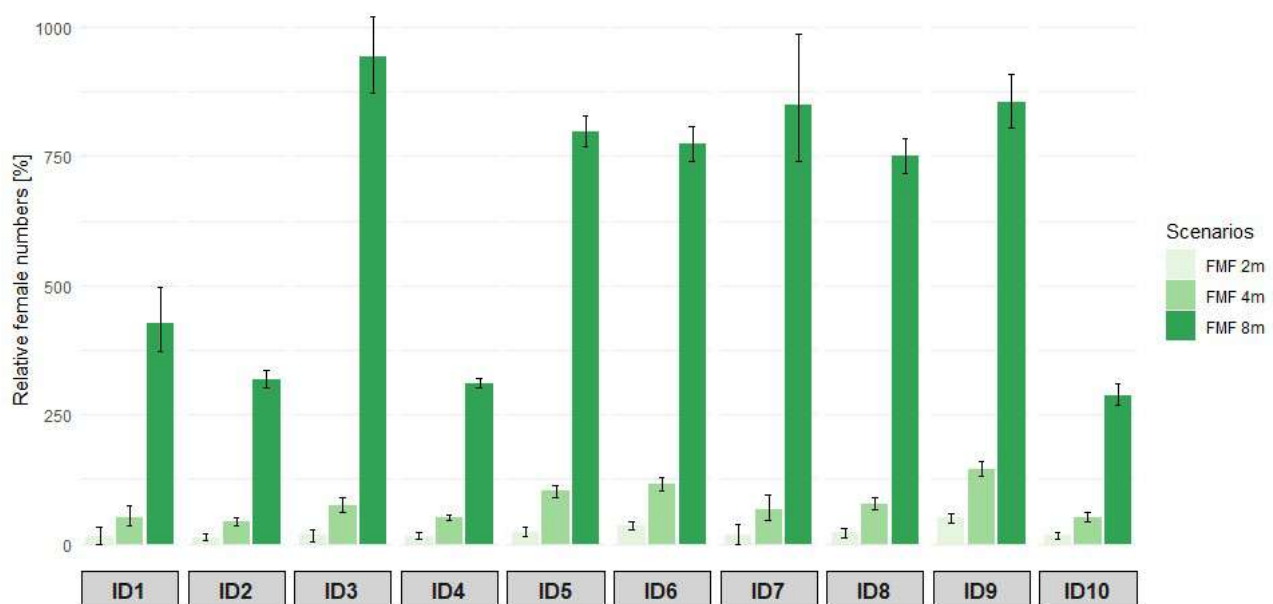


Figure 10.61 Flower field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

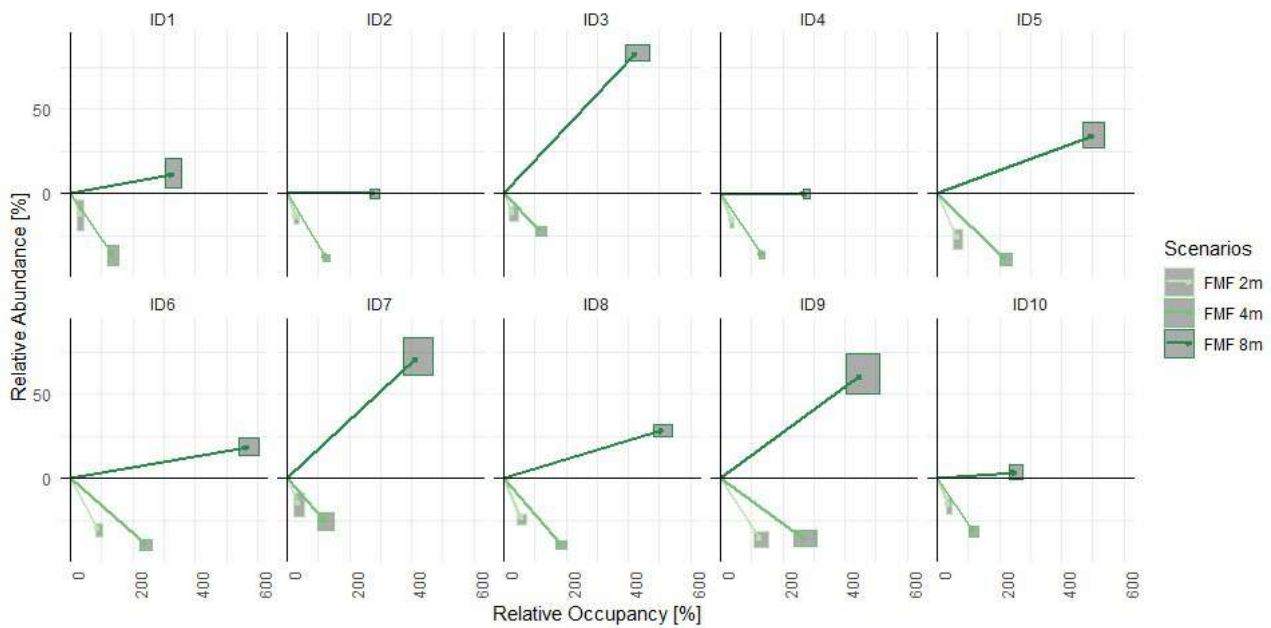


Figure 10.62 Flower field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5.2 Grassy field margins

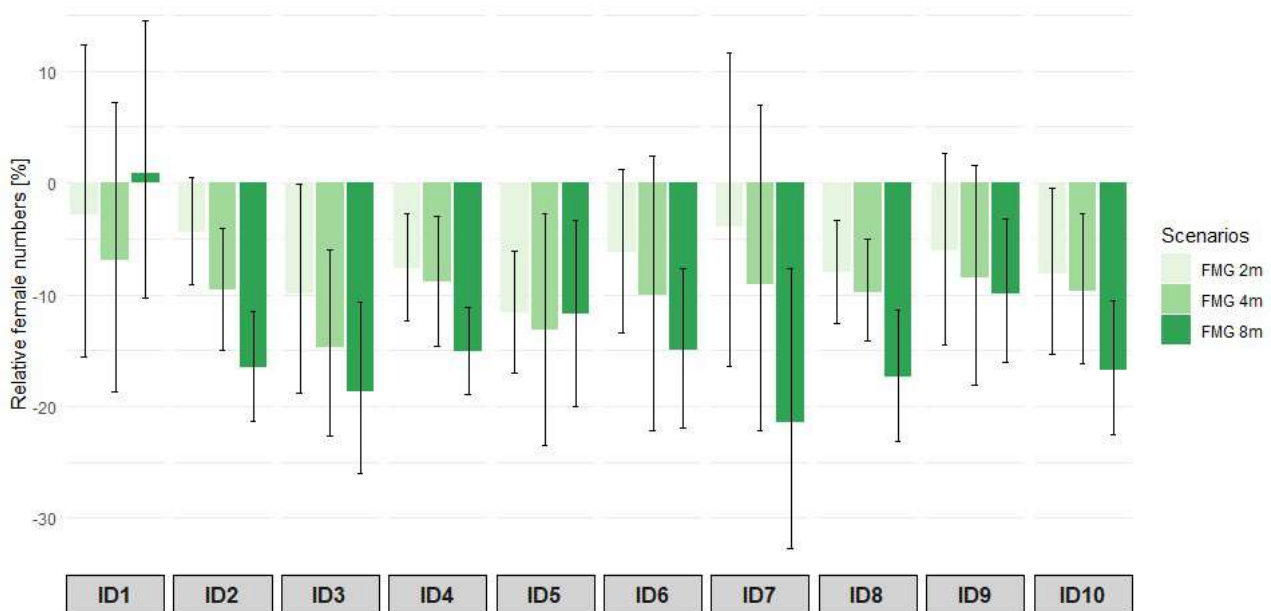


Figure 10.63 Grassy field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

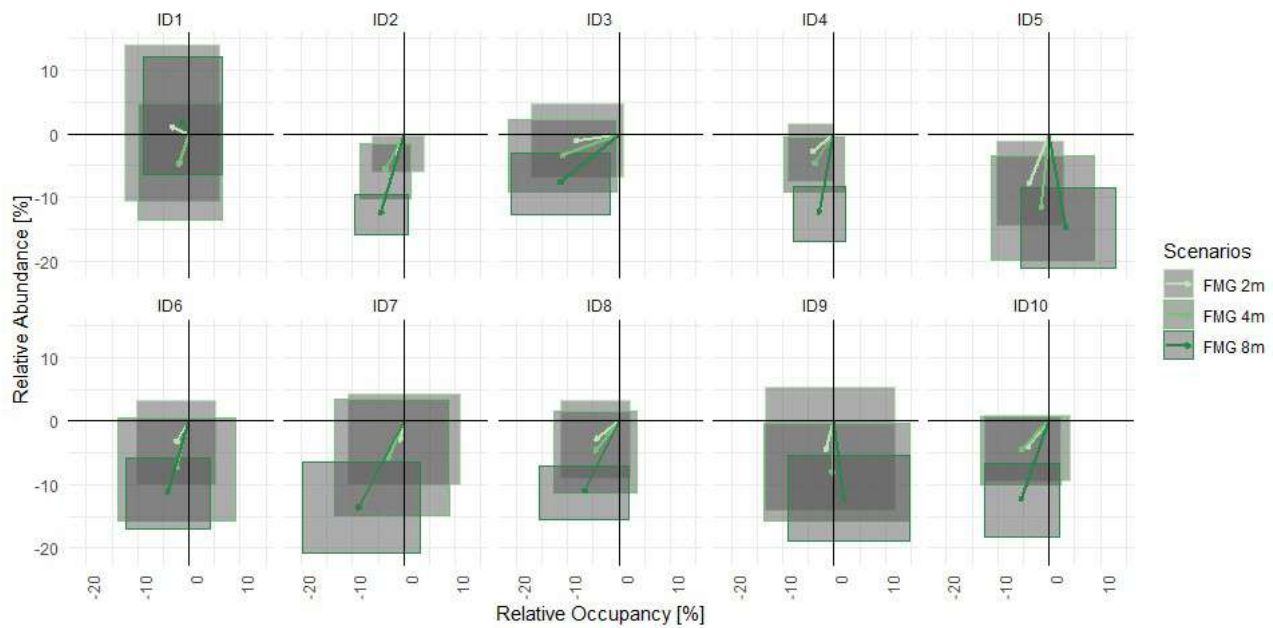


Figure 10.64 Grassy field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5.3 Mixed field margins

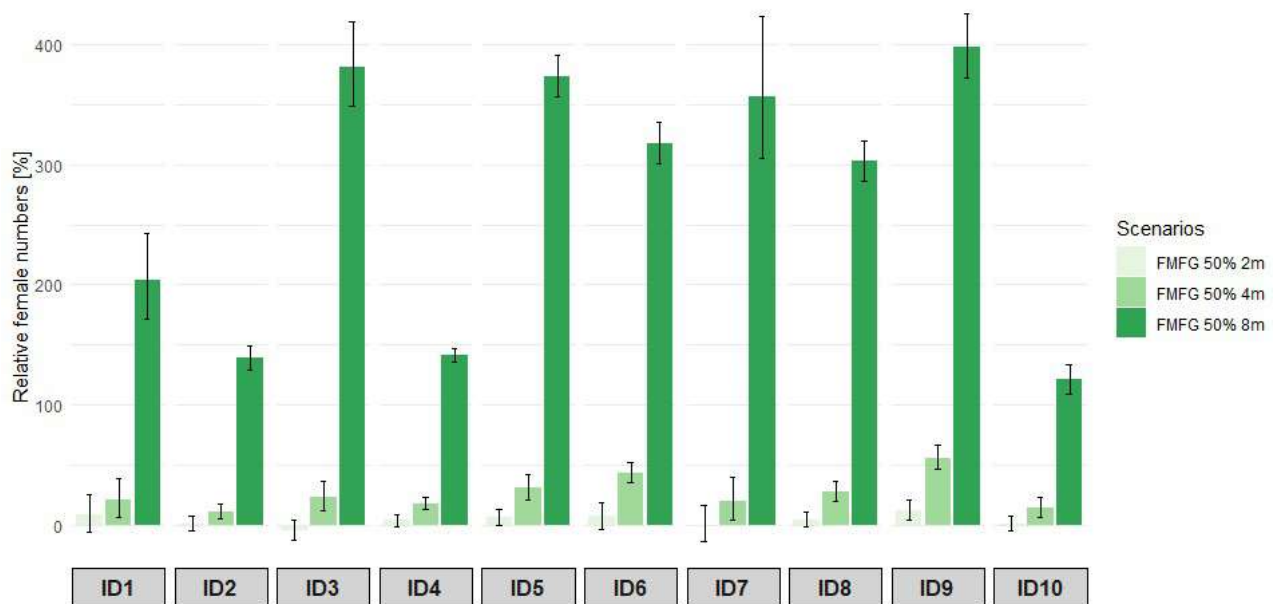


Figure 10.65 Mixed field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

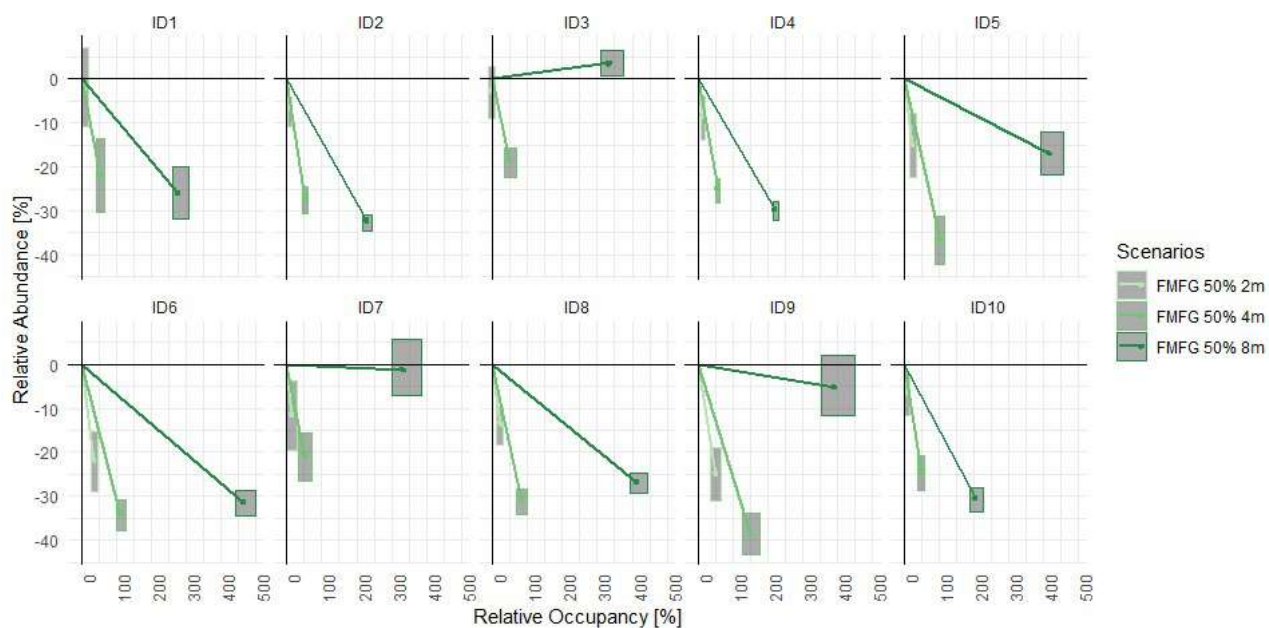


Figure 10.66 Mixed field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5.4 Flower, grassy and mixed field margins

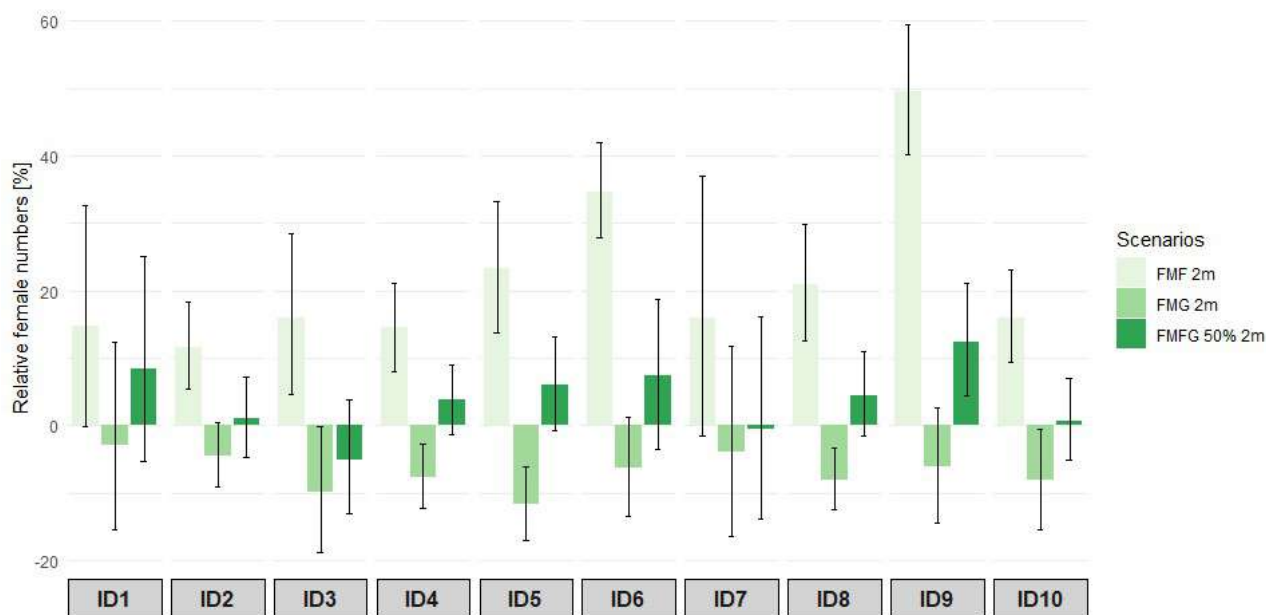


Figure 10.67 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

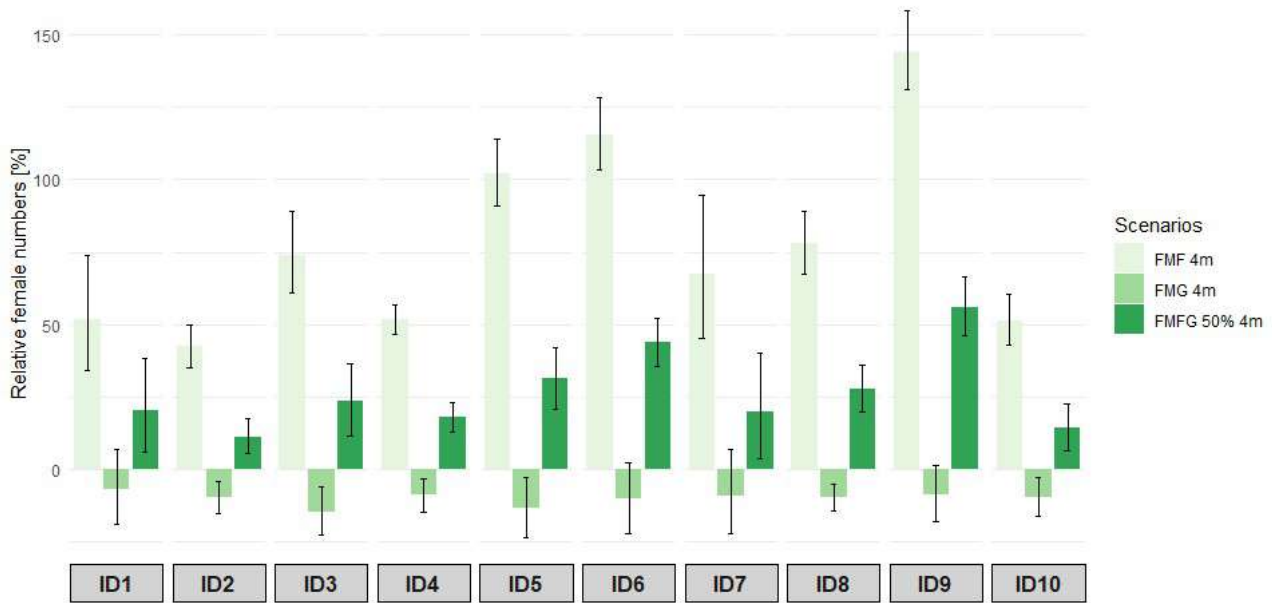


Figure 10.68 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

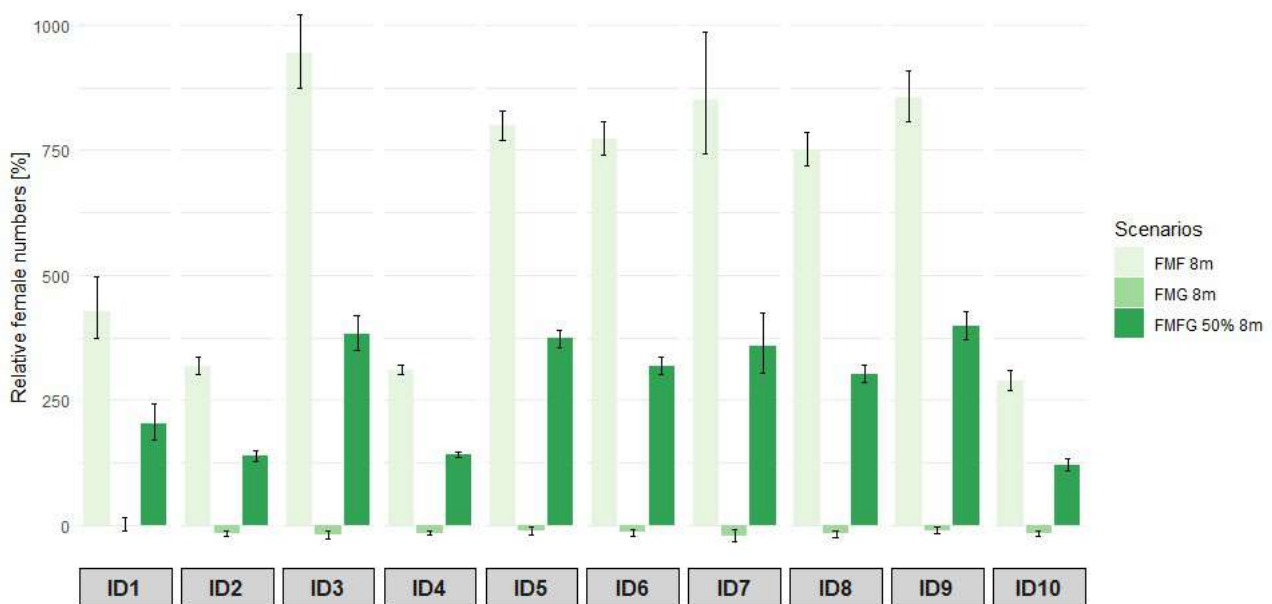


Figure 10.69 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

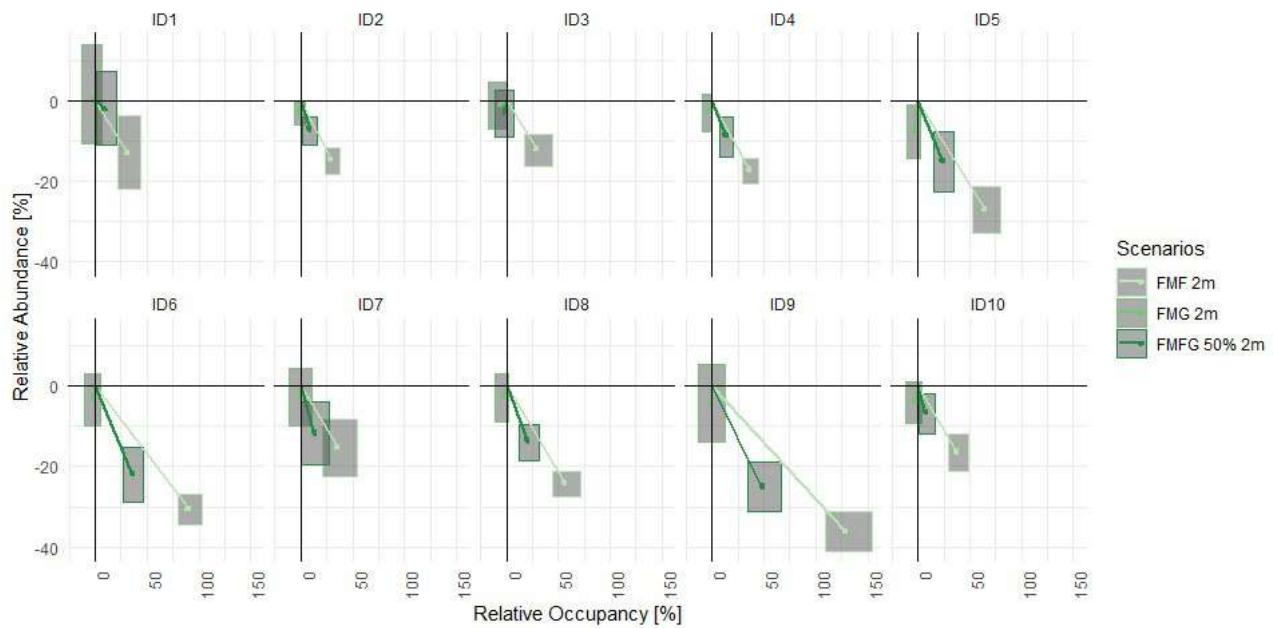


Figure 10.70 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

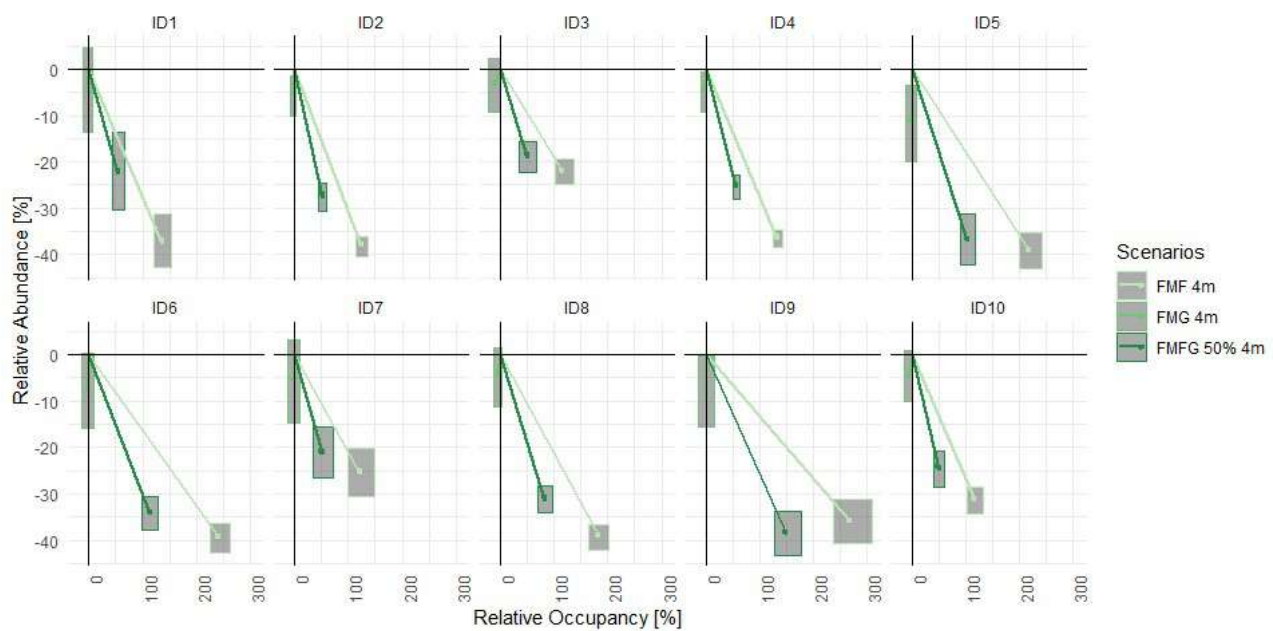


Figure 10.71 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes..

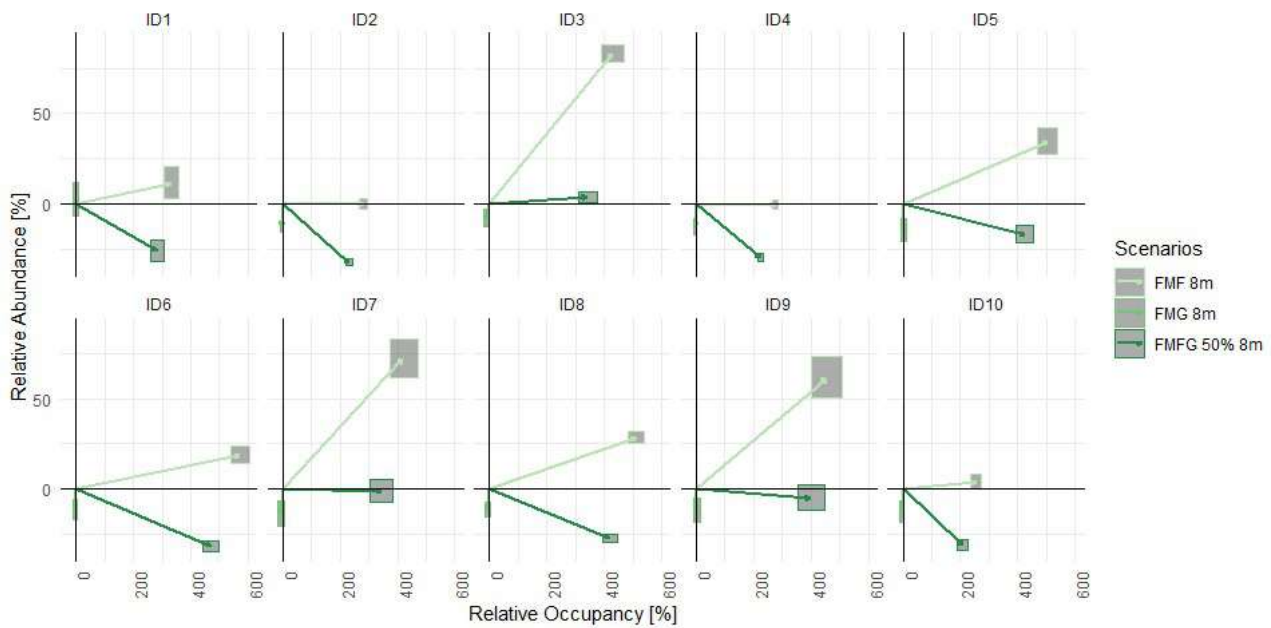


Figure 10.72 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5.5 Setaside

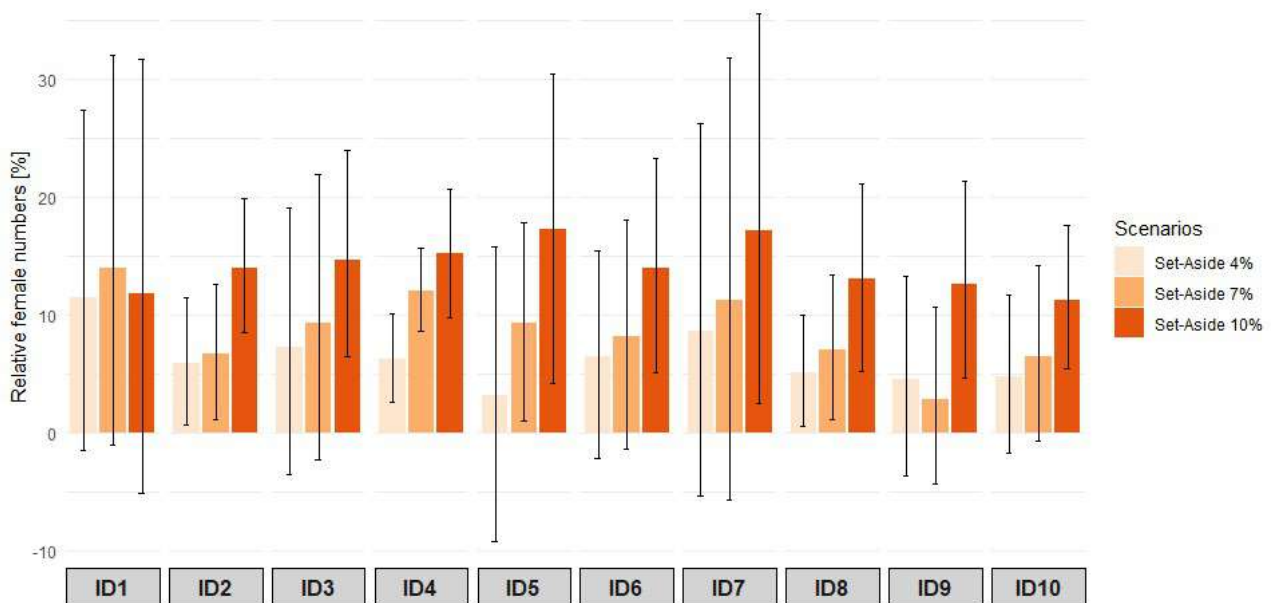


Figure 10.73 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

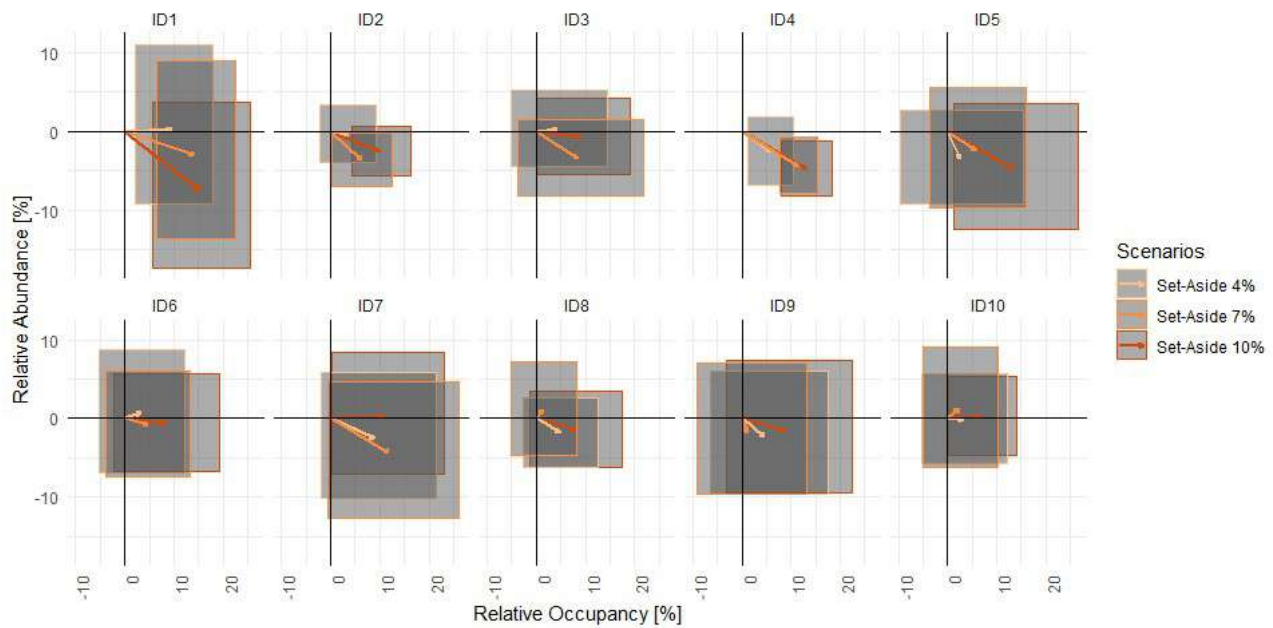


Figure 10.74 Setaside scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5.6 Legume

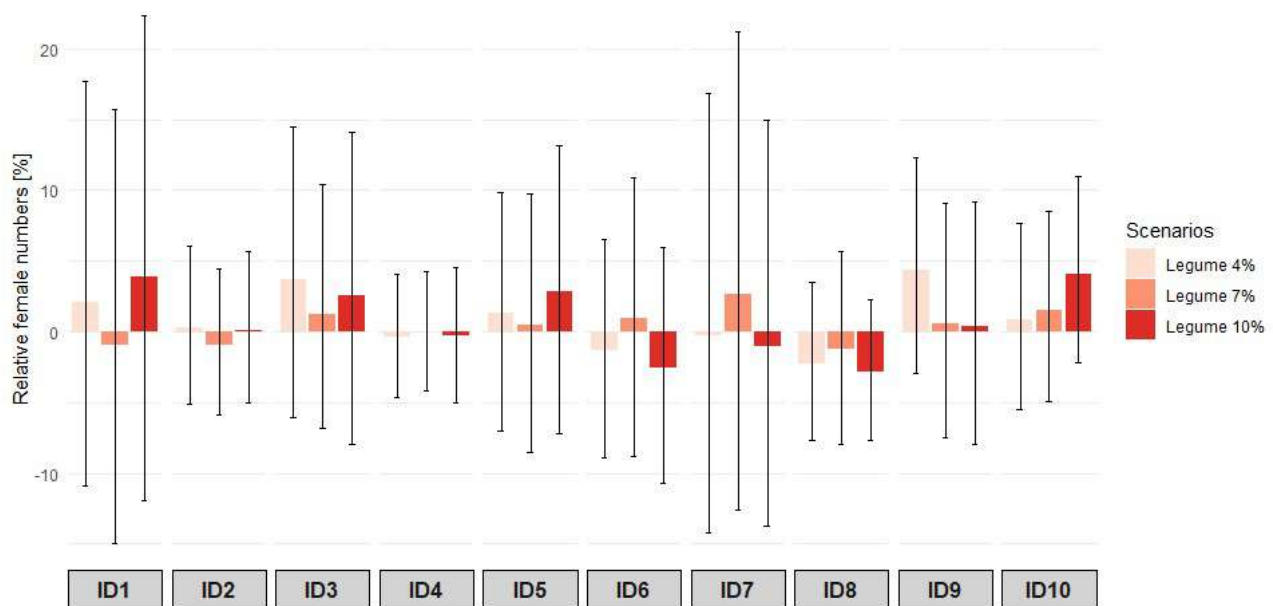


Figure 10.75 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

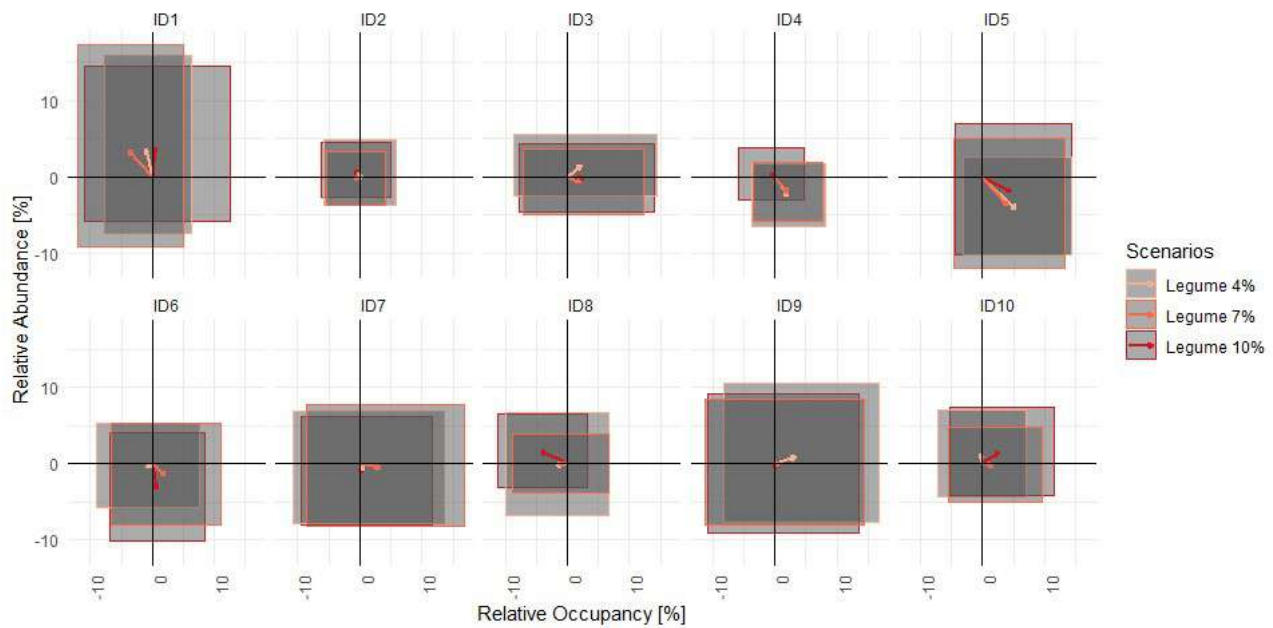


Figure 10.76 Legume scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.5.7 Biopesticides

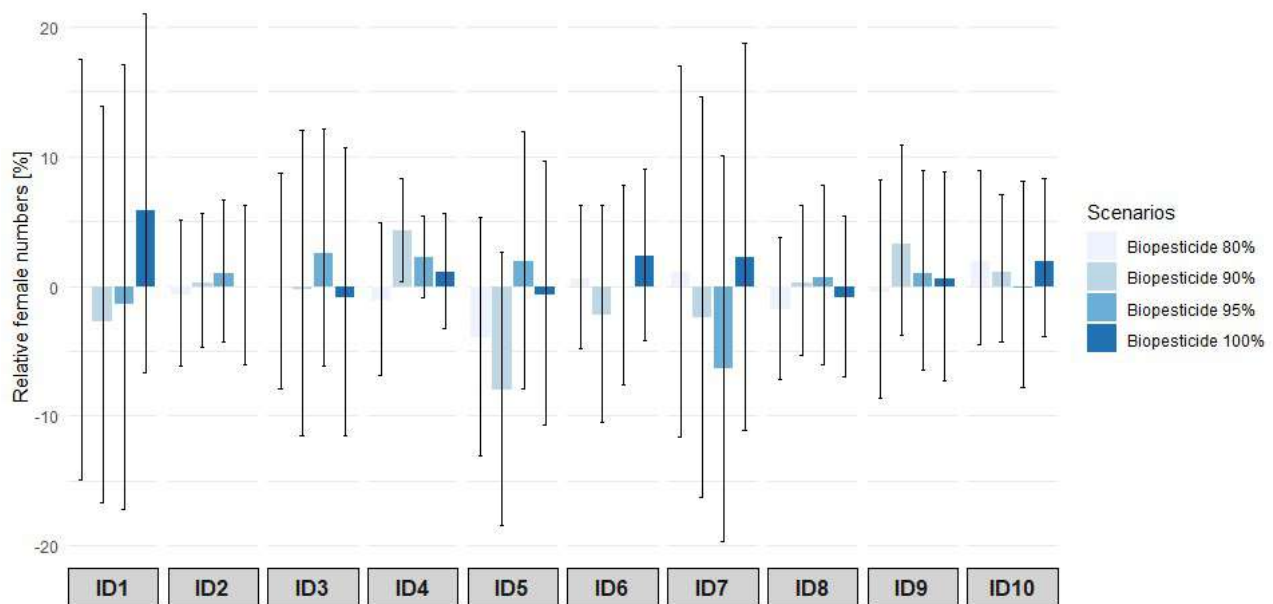


Figure 10.77 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in Finland.

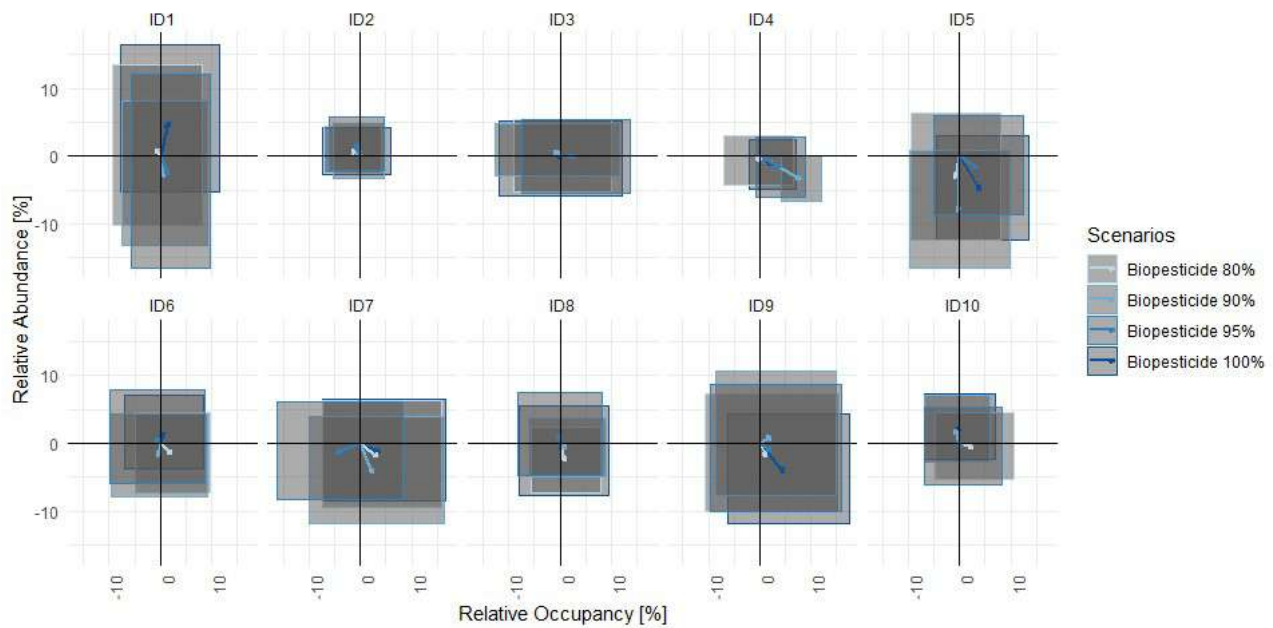


Figure 10.78 Biopesticide scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in Finland at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6 France

10.6.1 Flower field margins

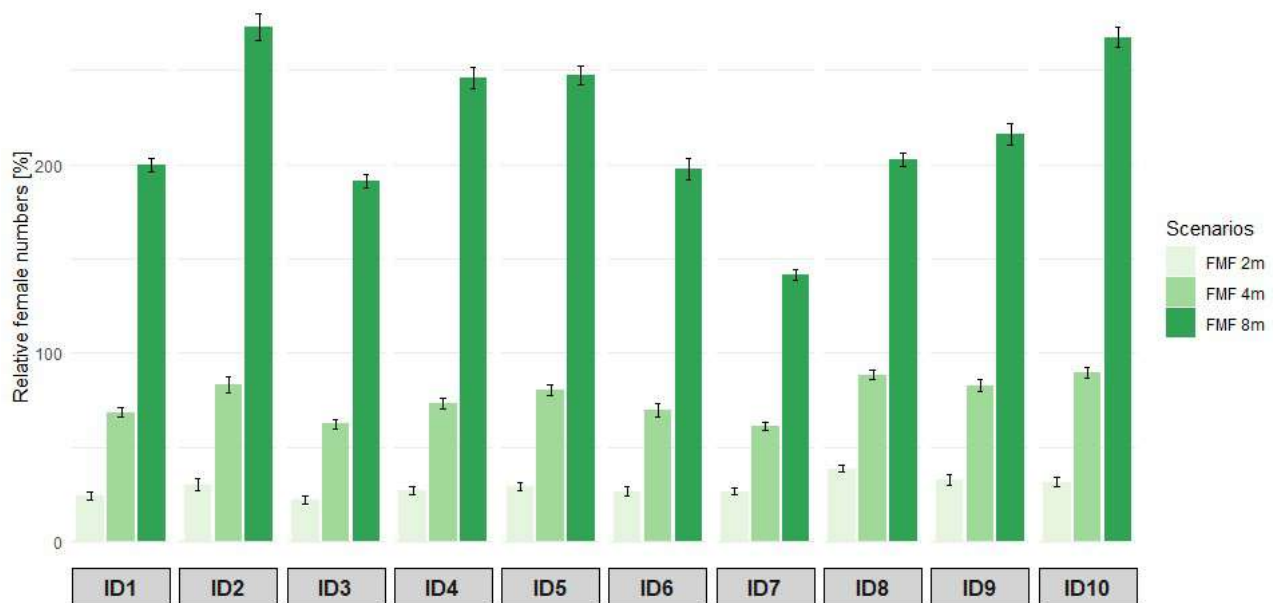


Figure 10.79 Flower field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

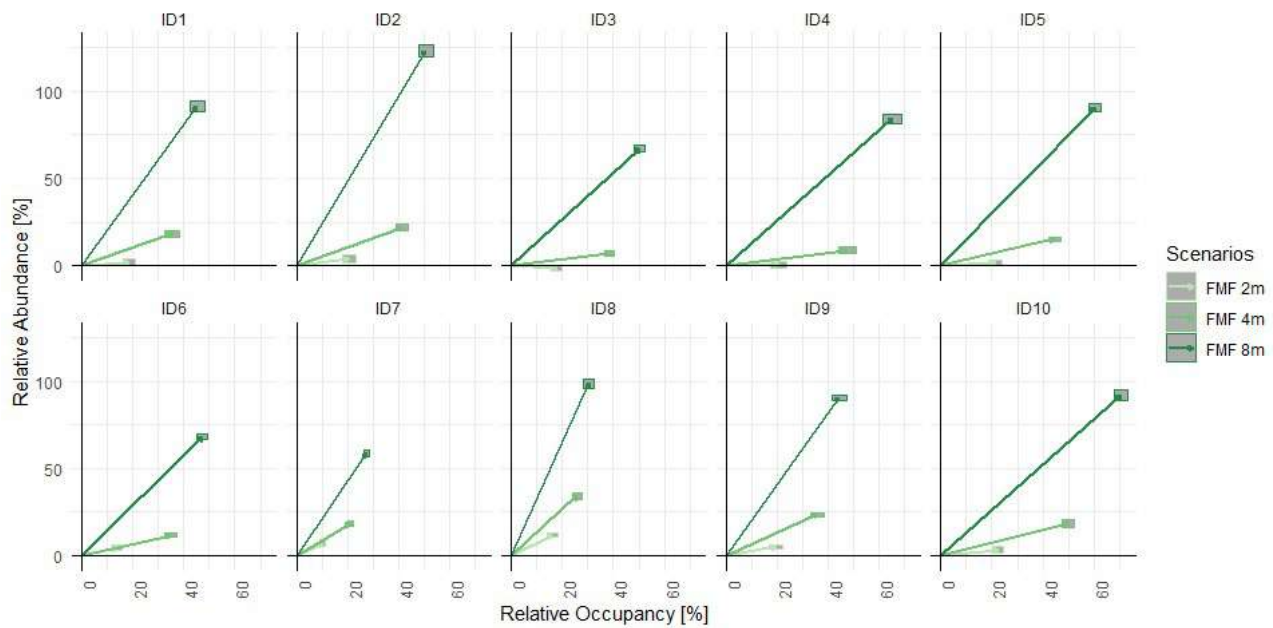


Figure 10.80 Flower field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6.2 Grassy field margins

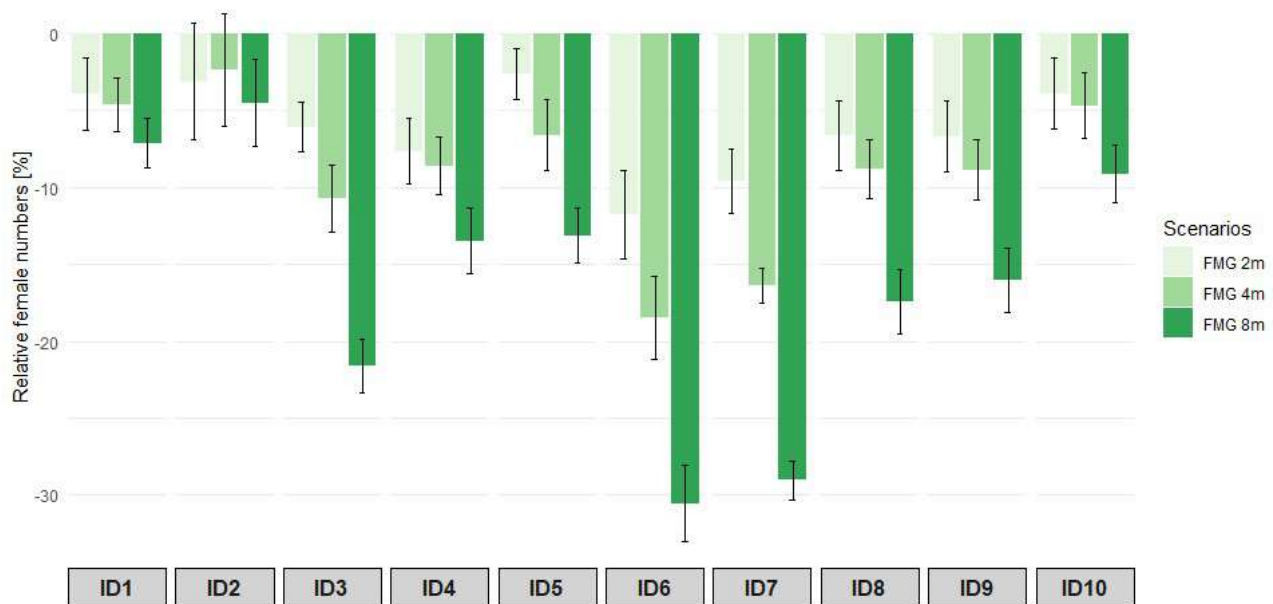


Figure 10.81 Grassy field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

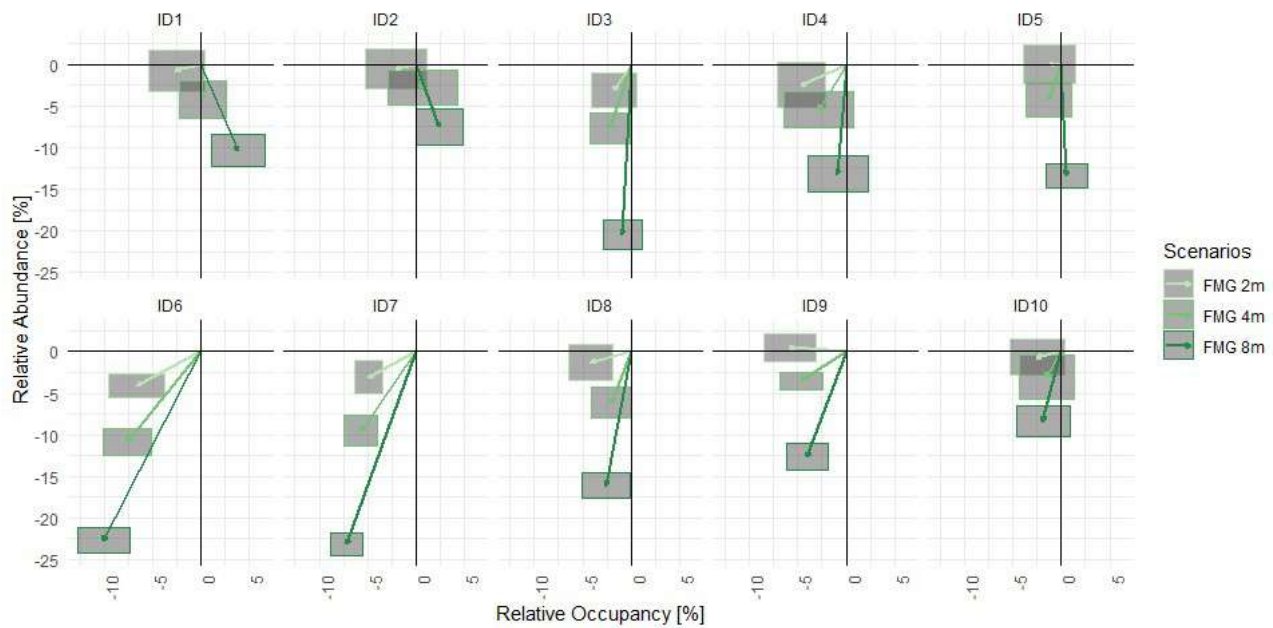


Figure 10.82 Grassy field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6.3 Mixed field margins

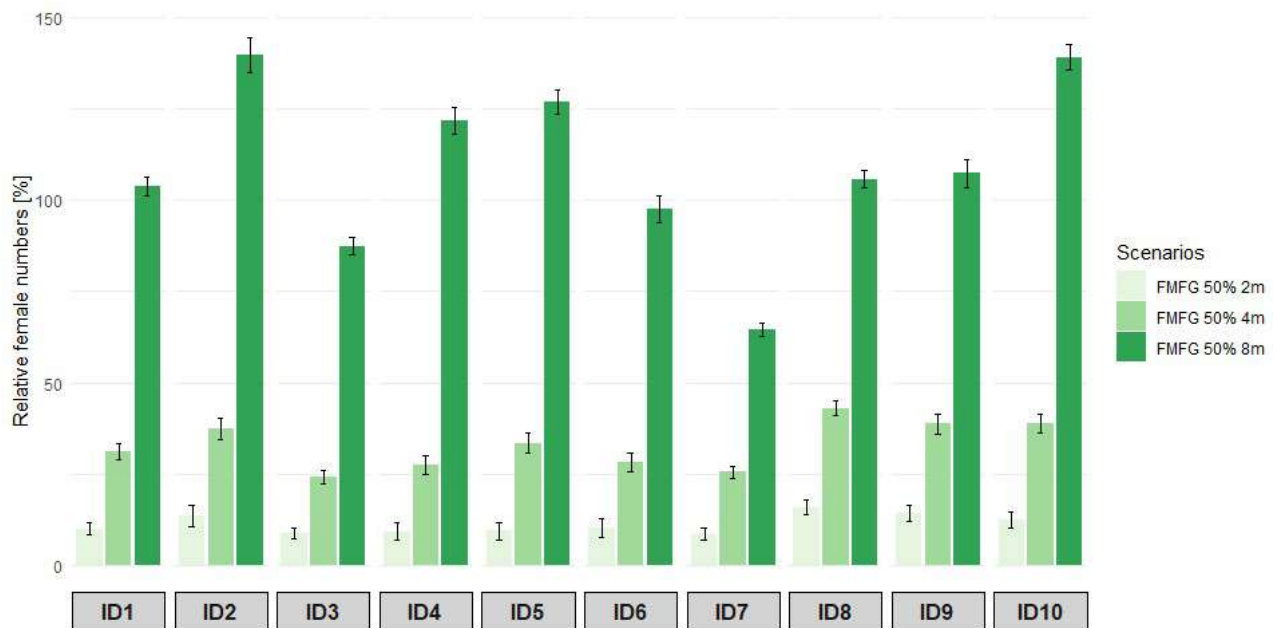


Figure 10.83 Mixed field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

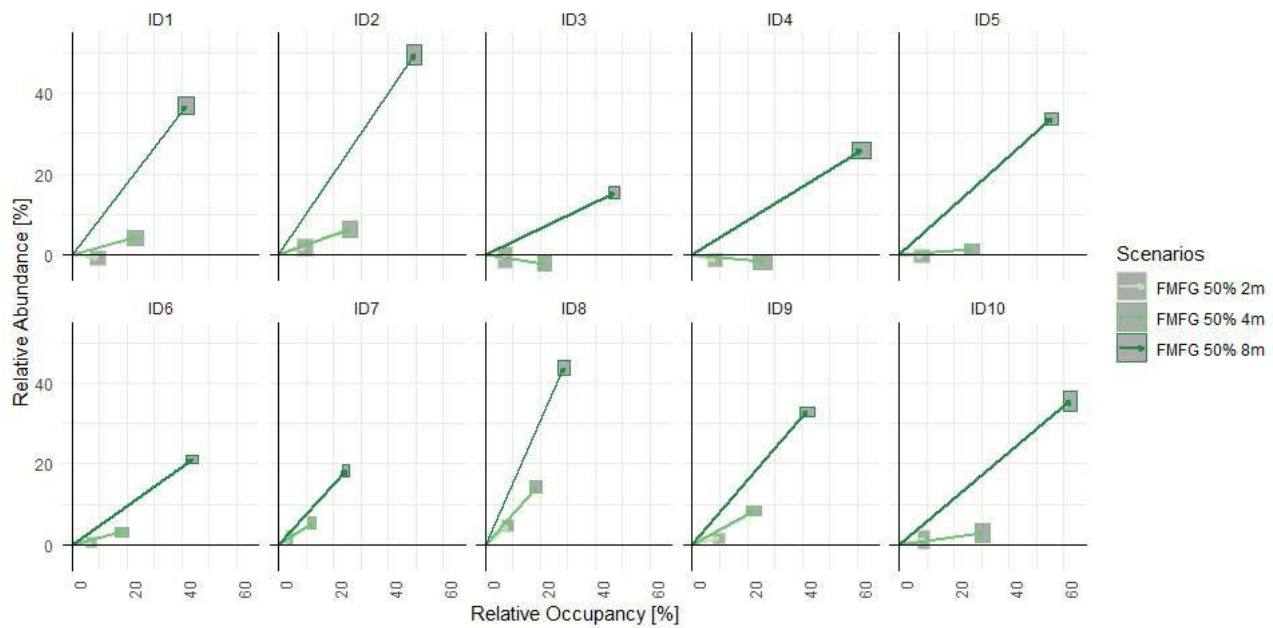


Figure 10.84 Mixed field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6.4 Flower, grassy and mixed field margins



Figure 10.85 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.



Figure 10.86 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.



Figure 10.87 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

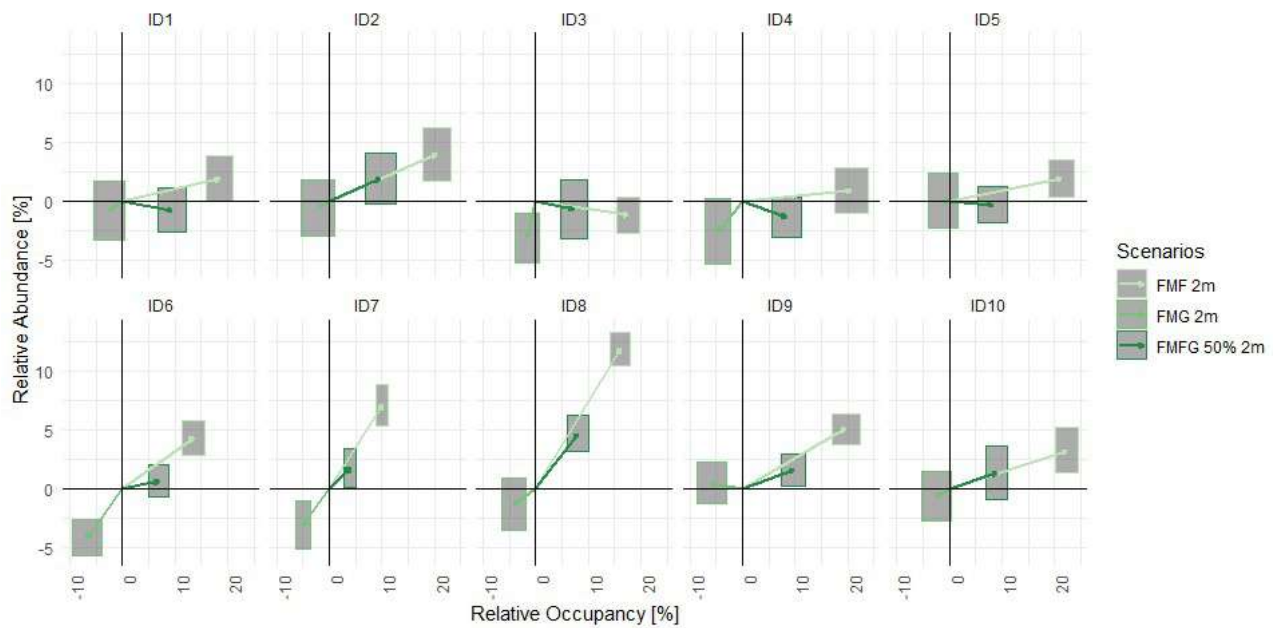


Figure 10.88 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

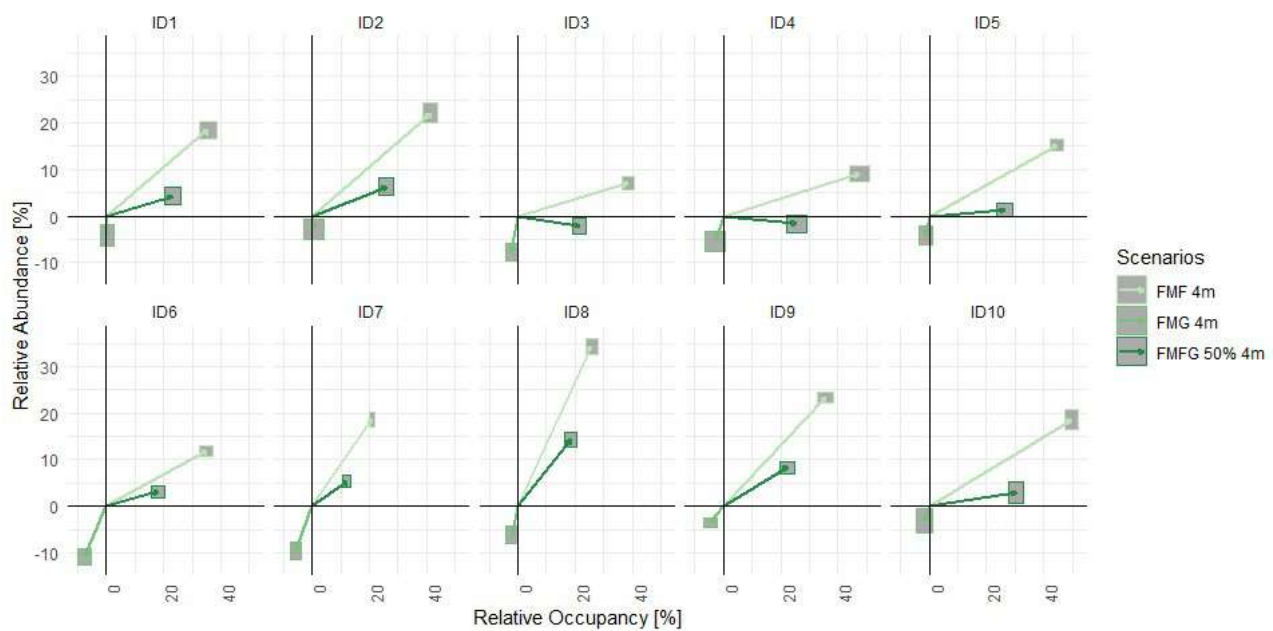


Figure 10.89 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France.. Grey areas indicate standard deviation along both axes..

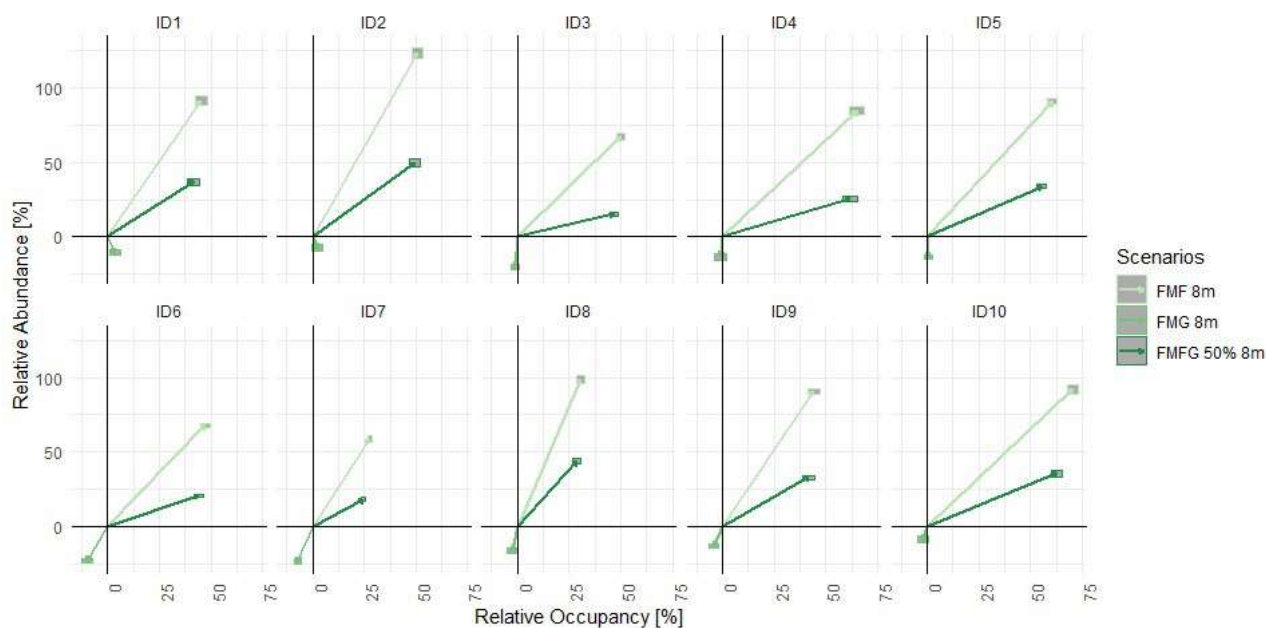


Figure 10.90 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6.5 Setaside

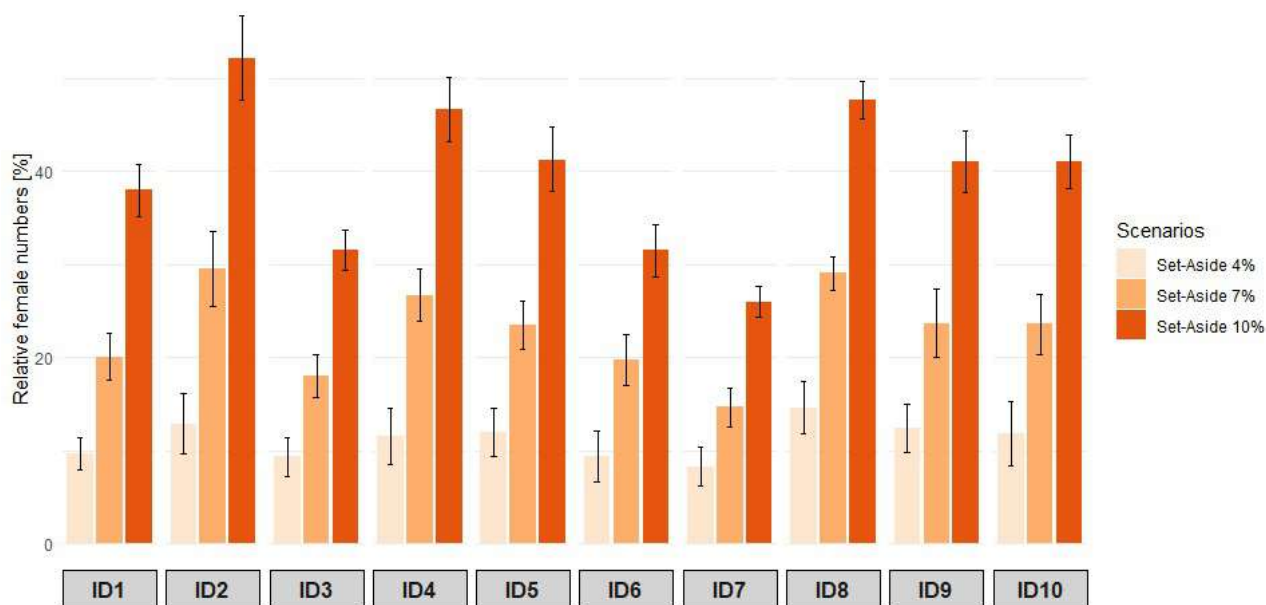


Figure 10.91 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

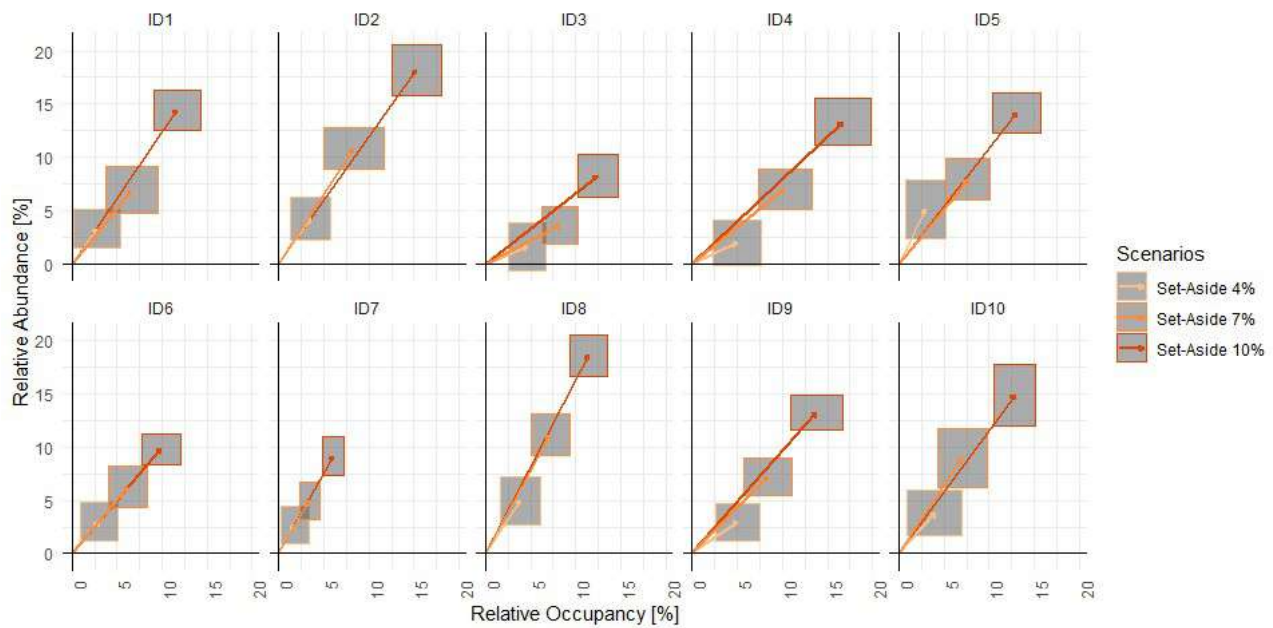


Figure 10.92 Setaside scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6.6 Legume

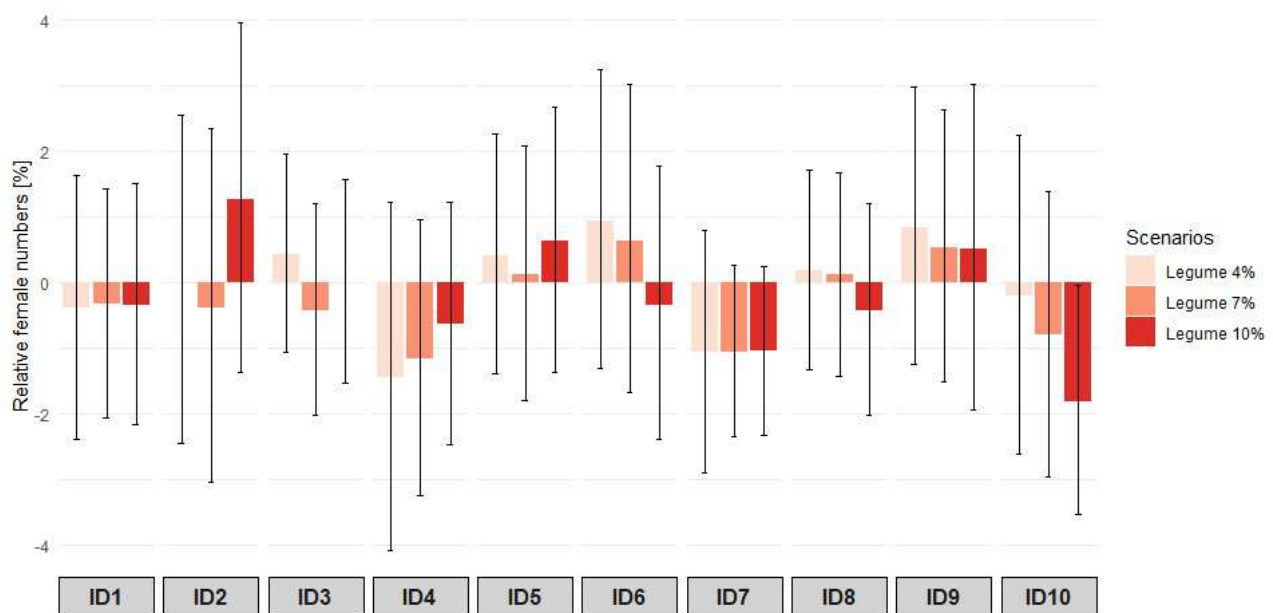


Figure 10.93 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

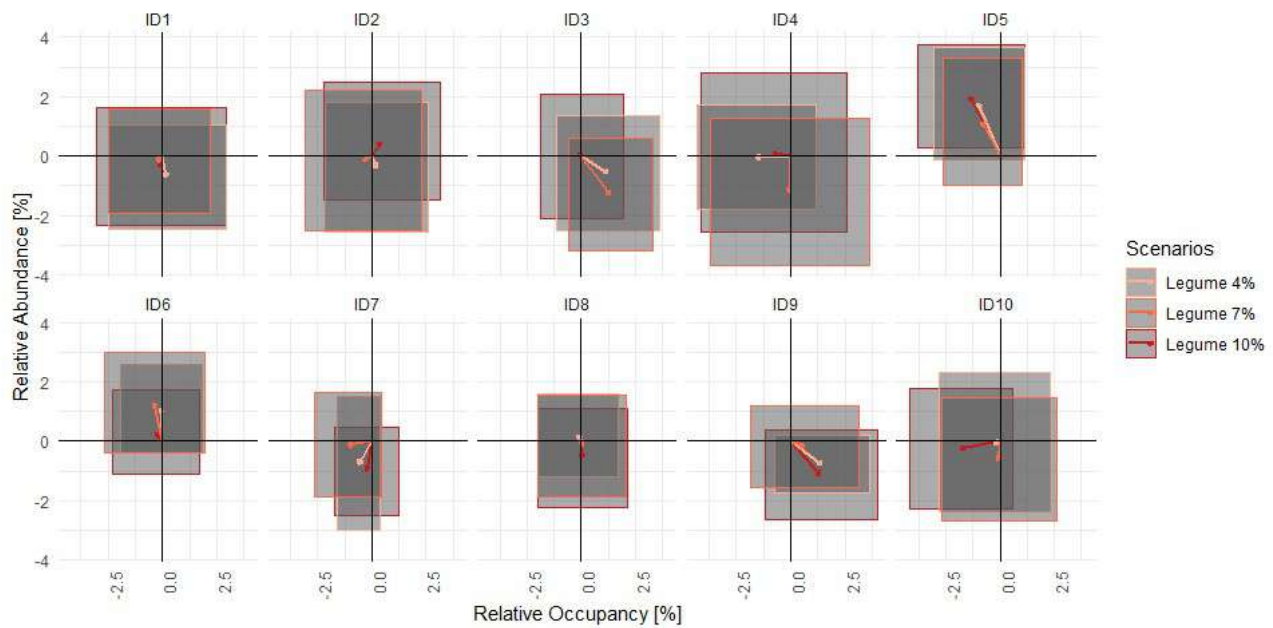


Figure 10.94 Legume scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.6.7 Biopesticides

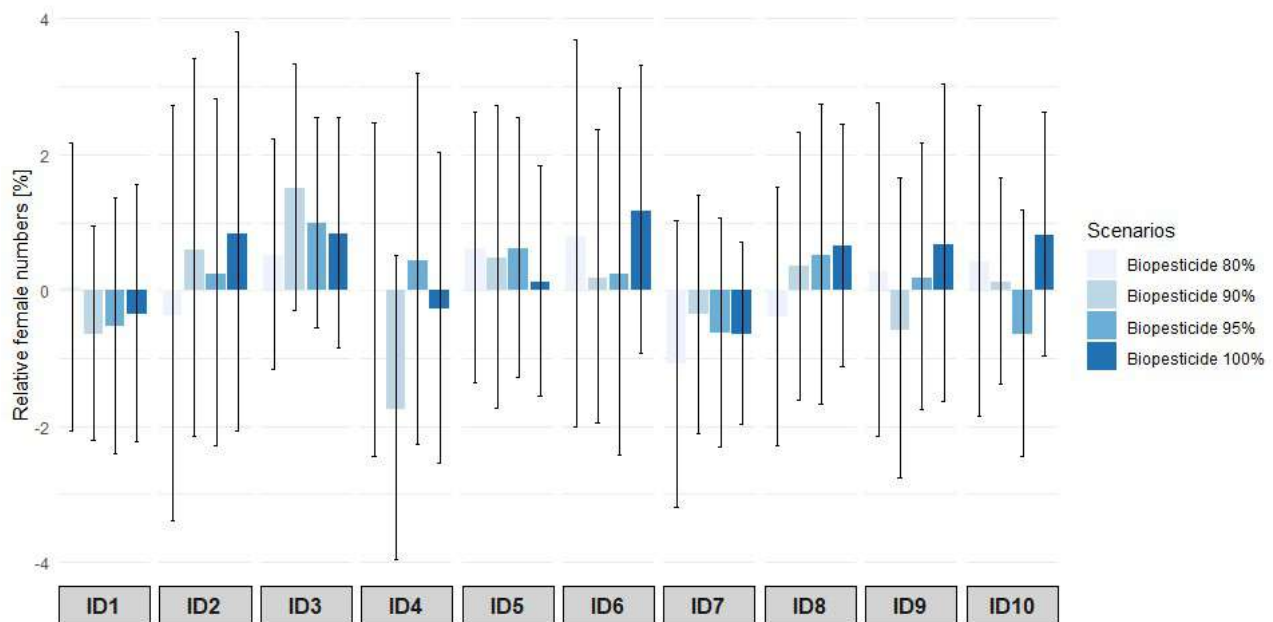


Figure 10.95 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in France.

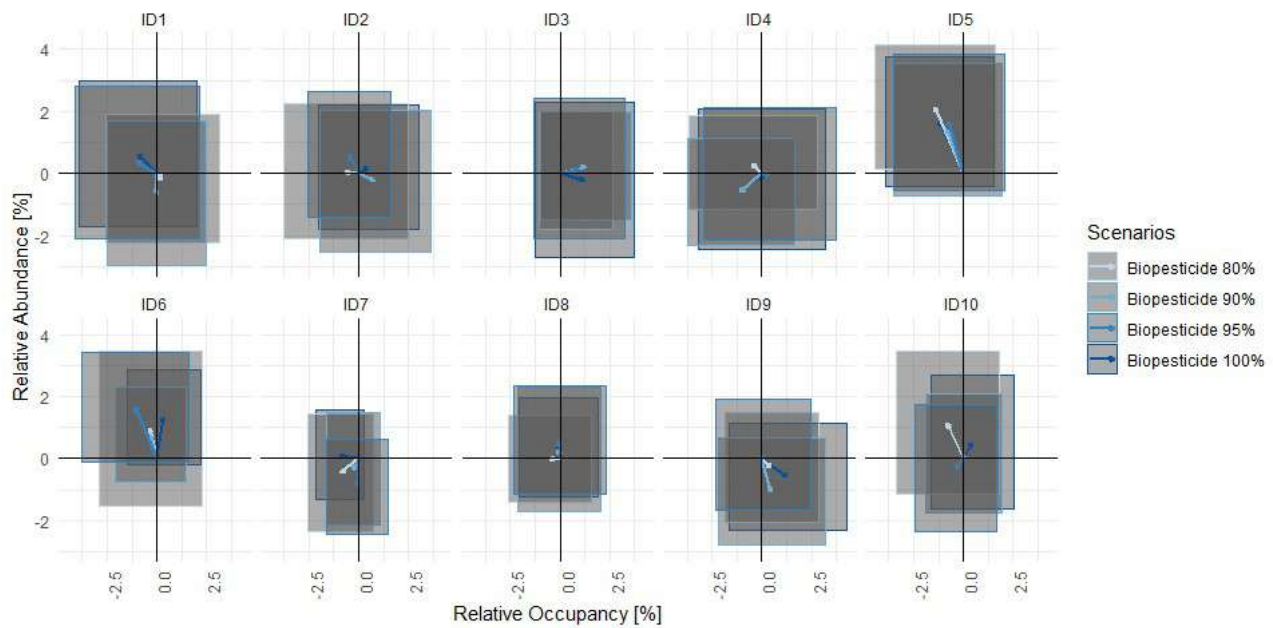


Figure 10.96 Biopesticide scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in France at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7 Netherlands

10.7.1 Flower field margins

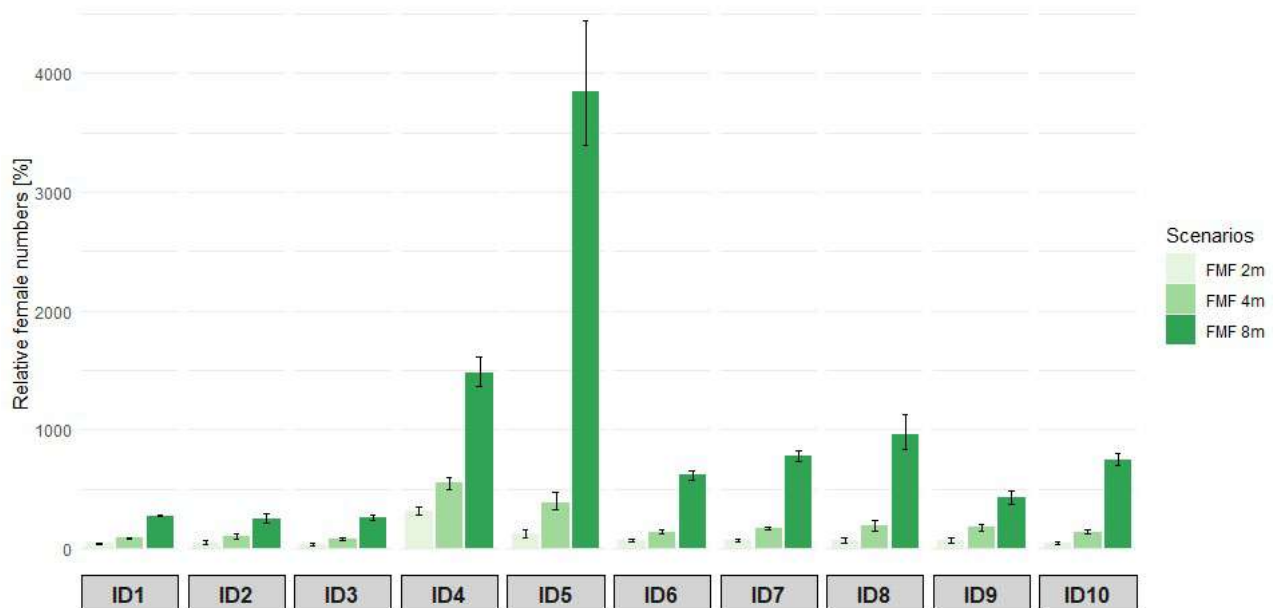


Figure 10.97 Flower field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

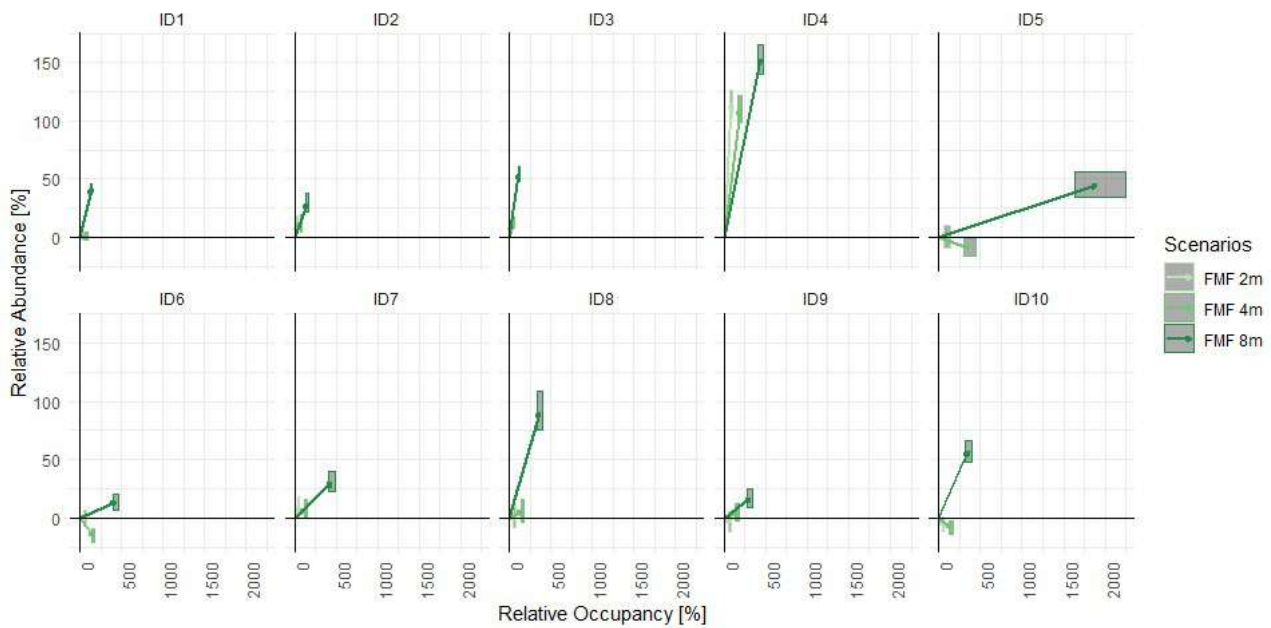


Figure 10.98 Flower field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7.2 Grassy field margins

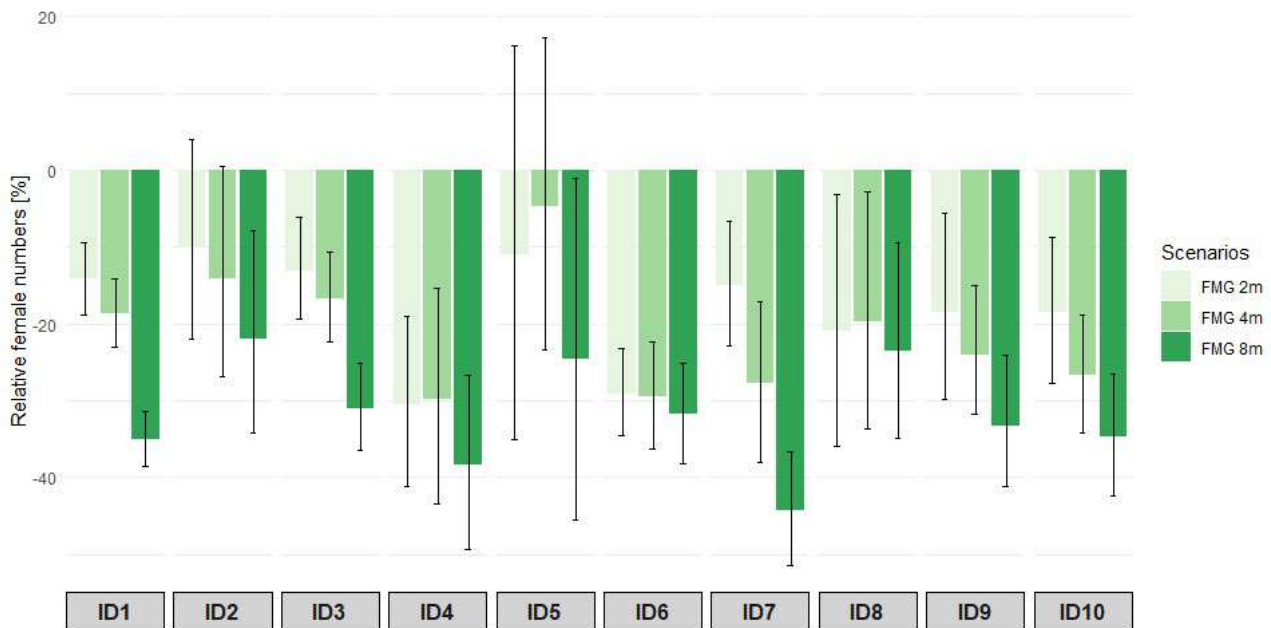


Figure 10.99 Grassy field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

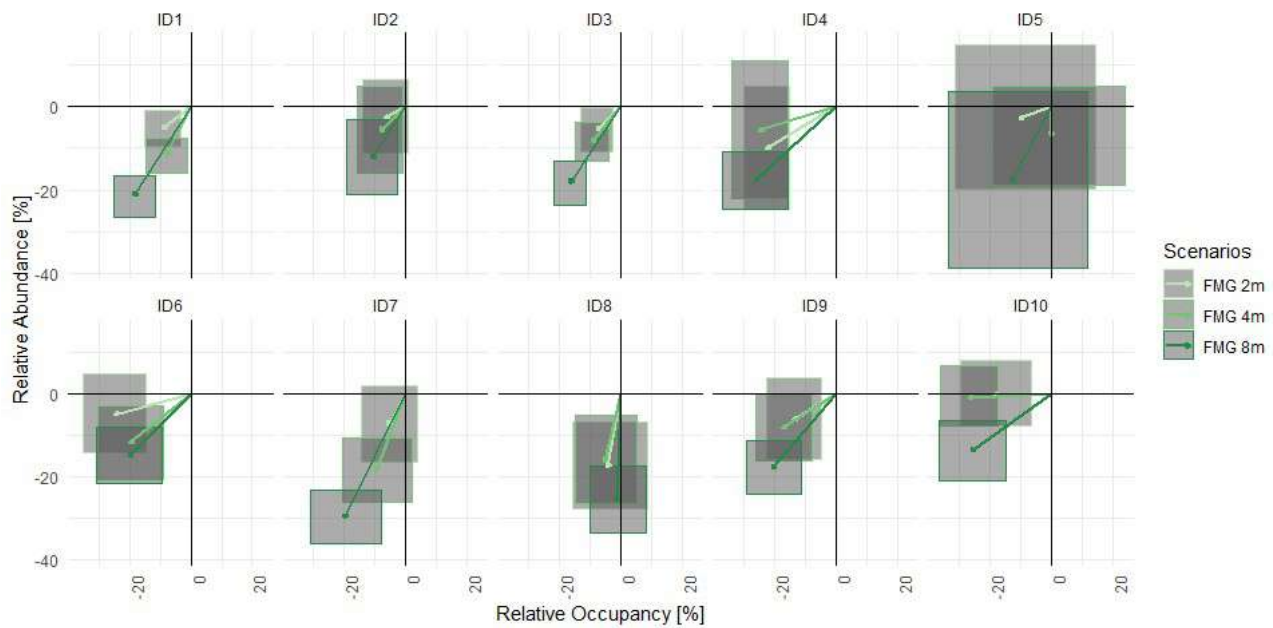


Figure 10.100 Grassy field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7.3 Mixed field margins

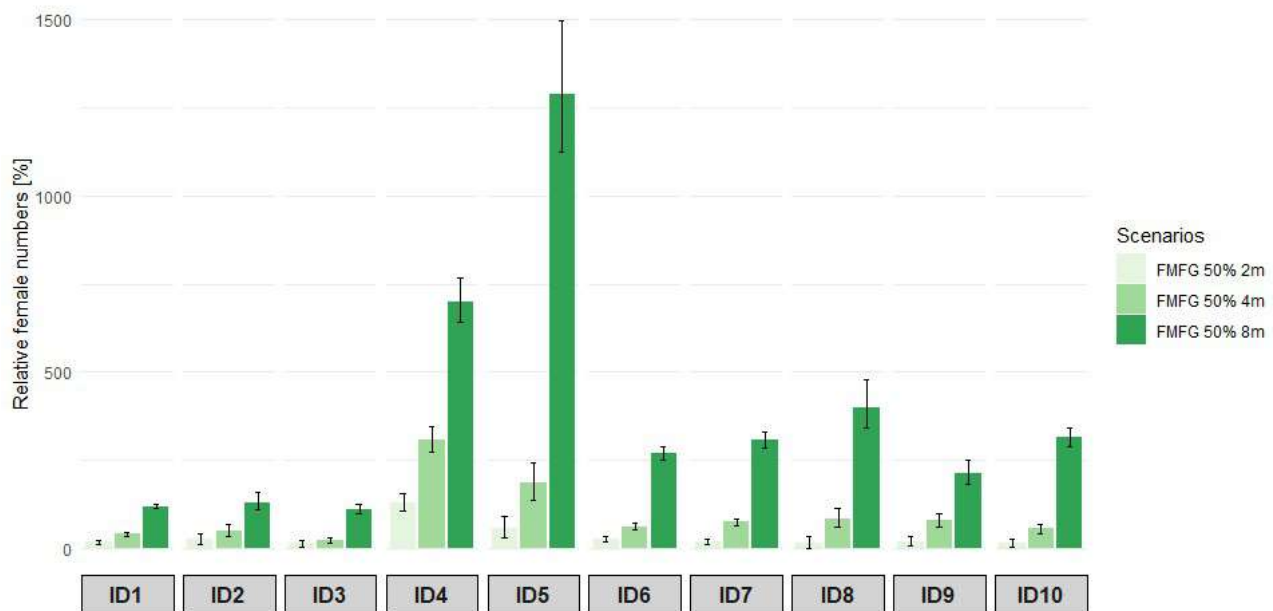


Figure 10.101 Mixed field margins scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

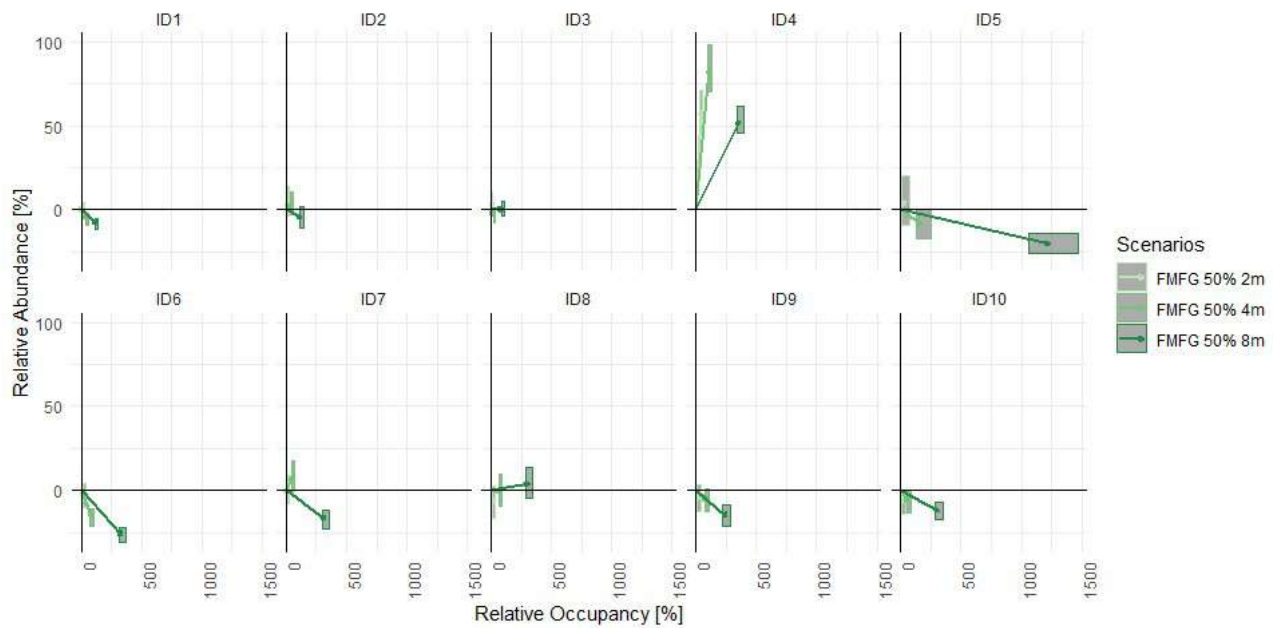


Figure 10.102 Mixed field margins with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7.4 Flower, grassy and mixed field margins

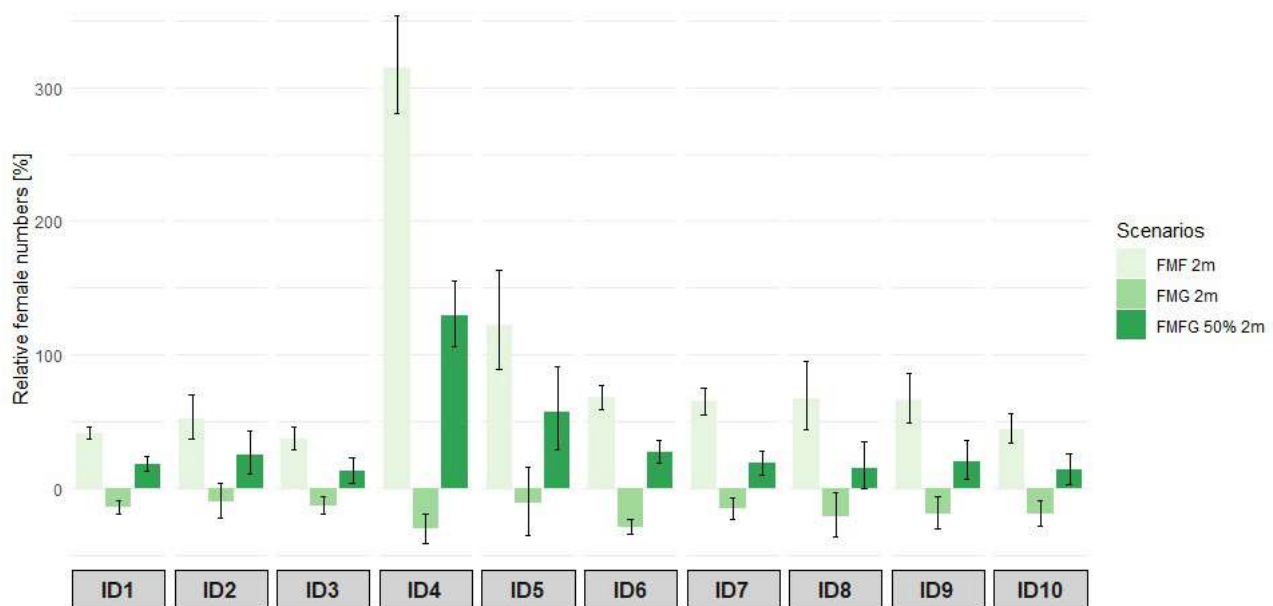


Figure 10.103 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

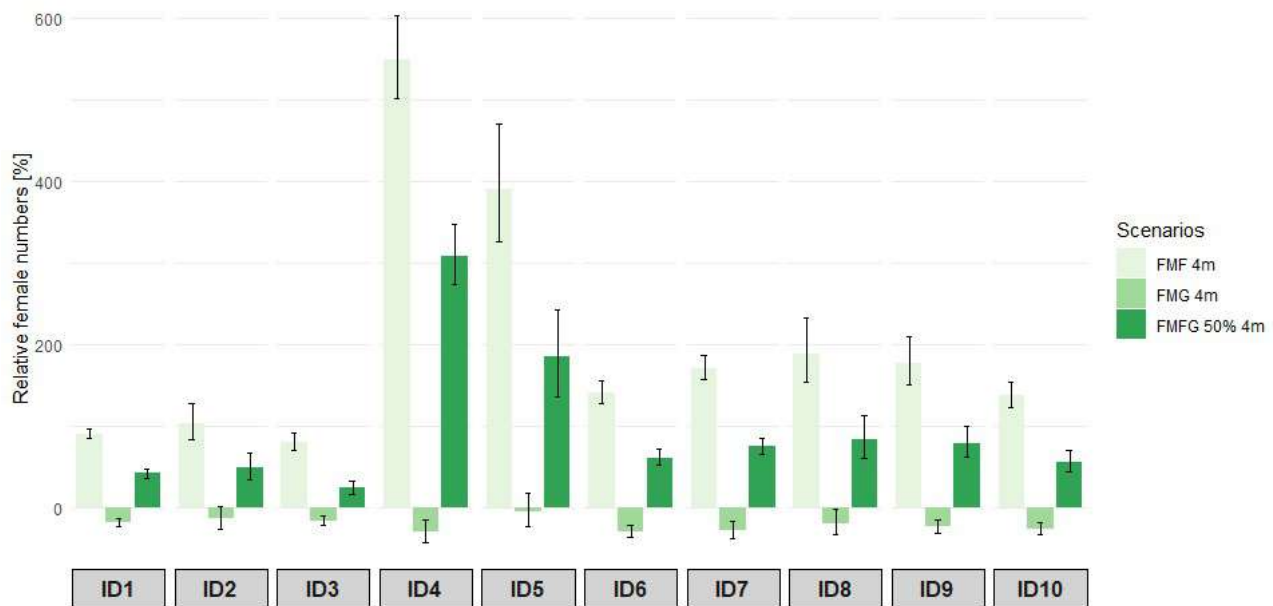


Figure 10.104 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

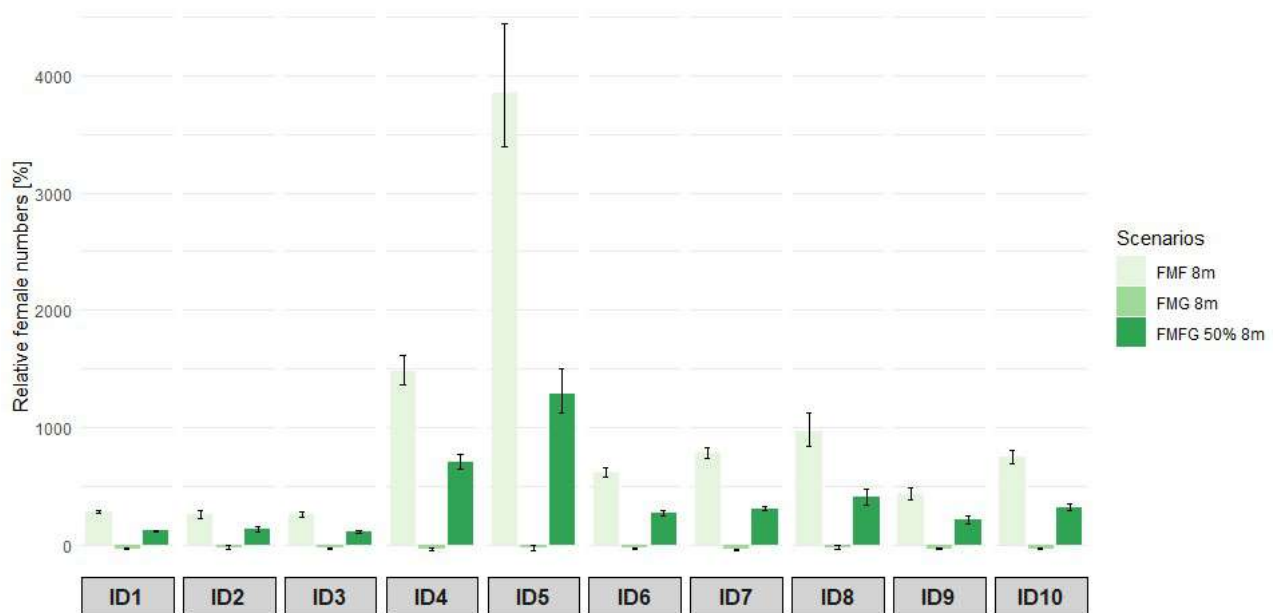


Figure 10.105 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

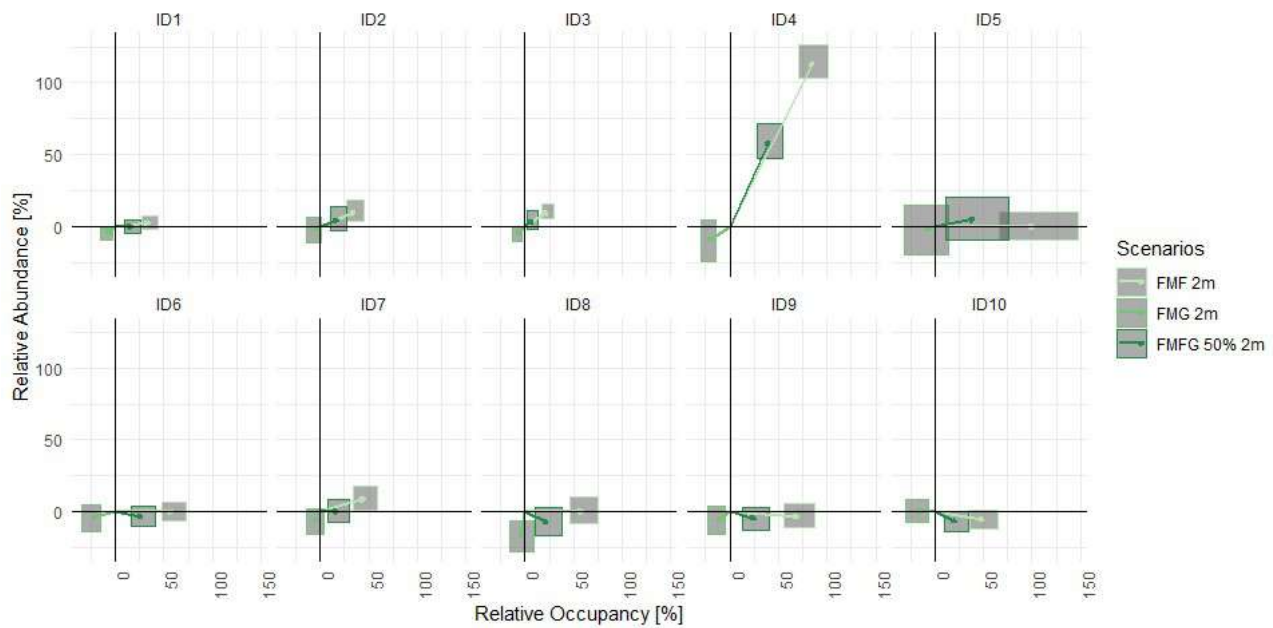


Figure 10.106 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

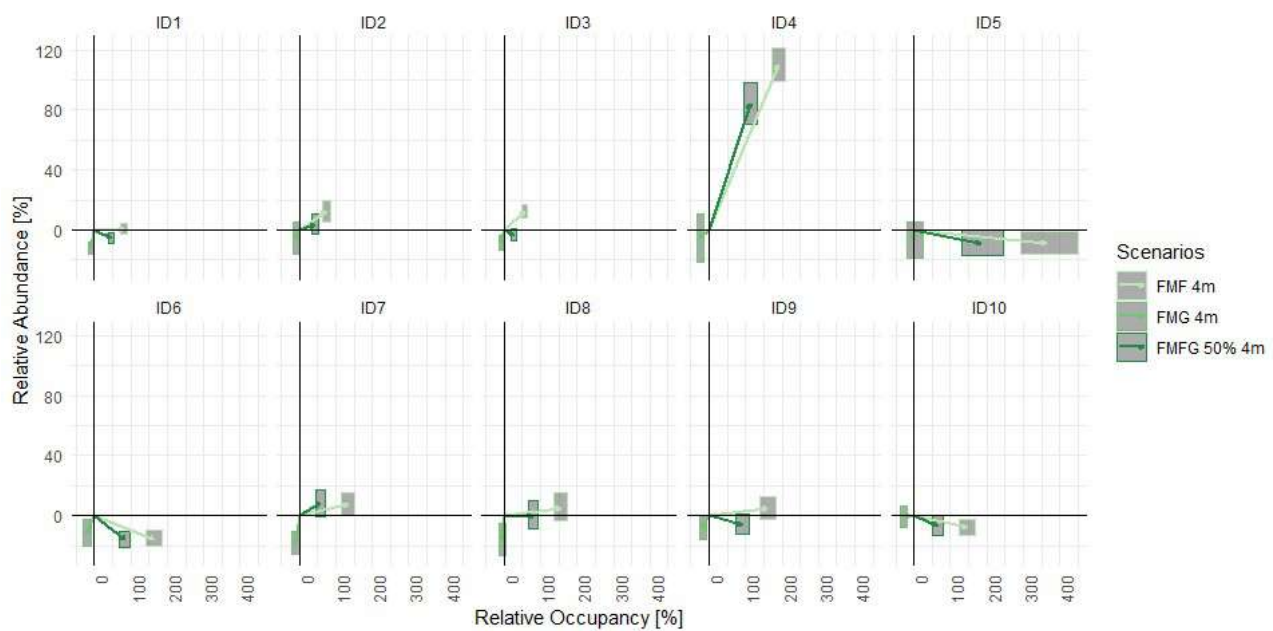


Figure 10.107 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes..

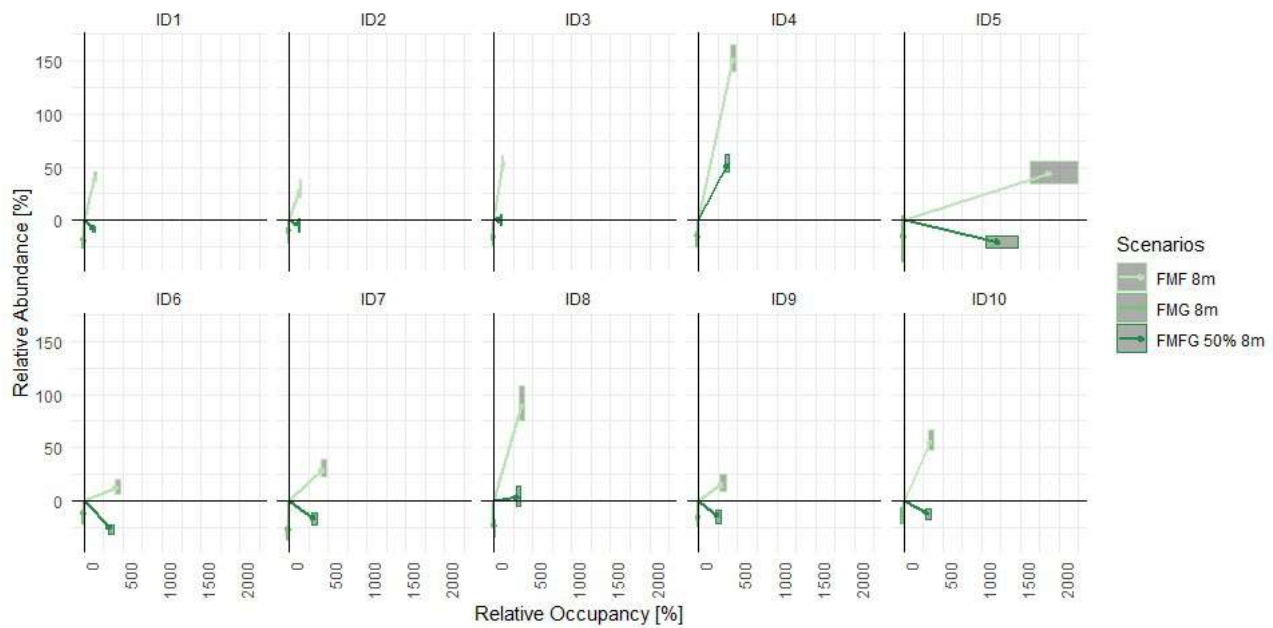


Figure 10.108 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7.5 Setaside

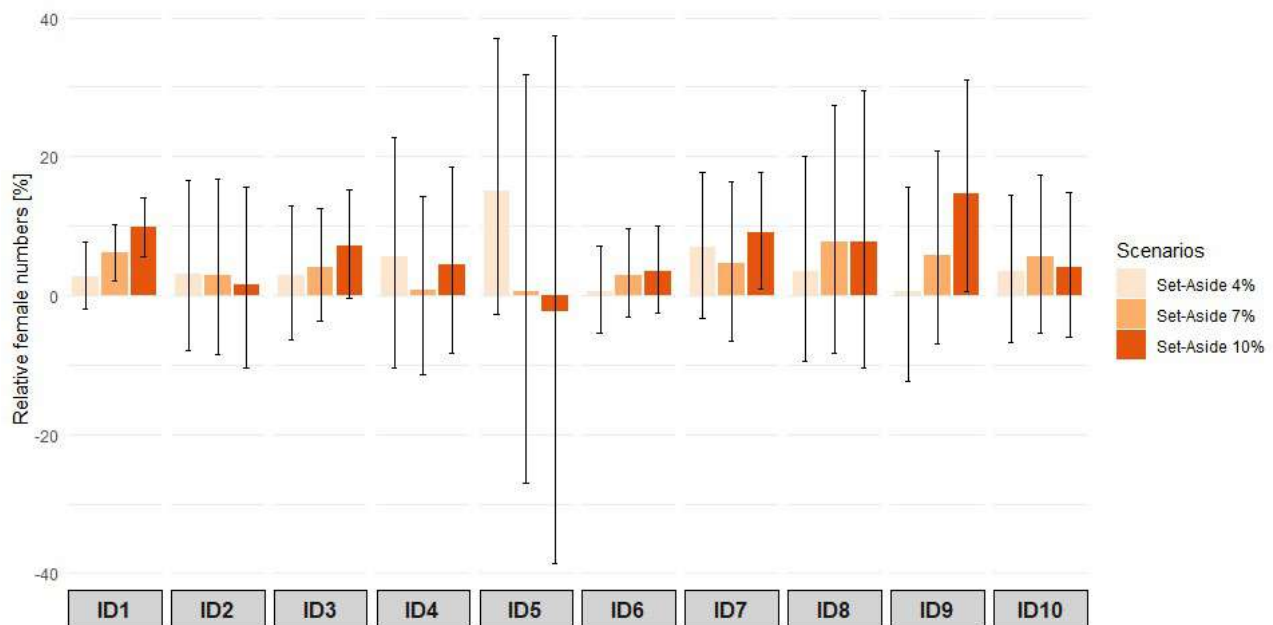


Figure 10.109 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

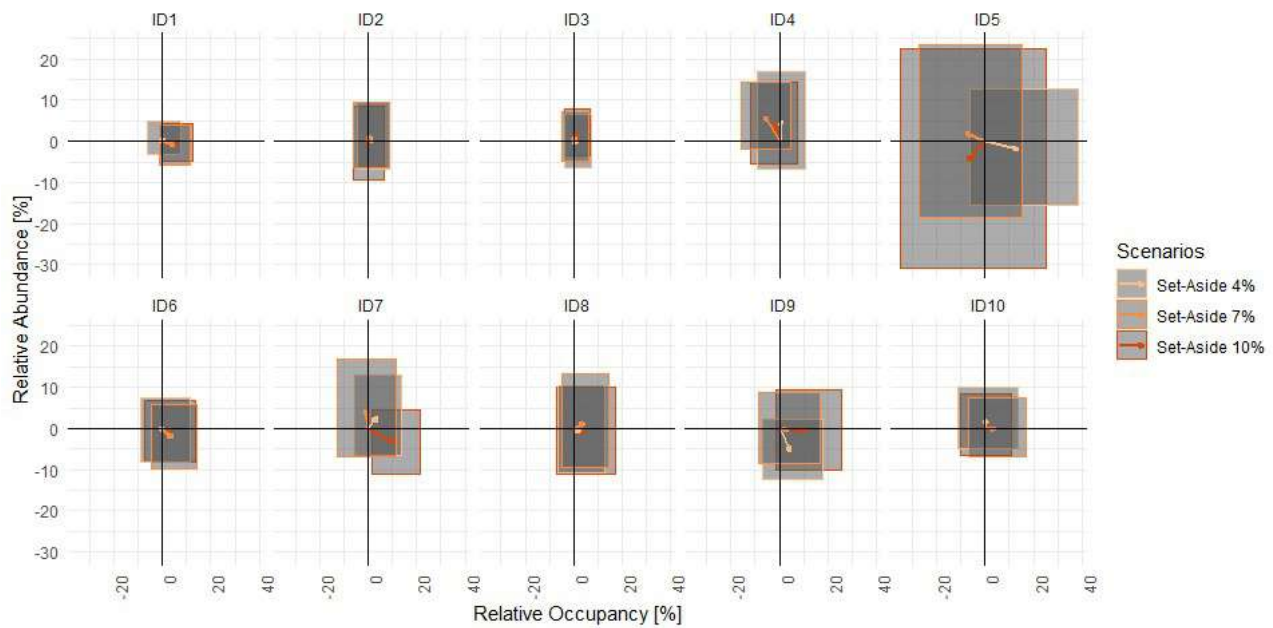


Figure 10.110 Setaside scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7.6 Legume

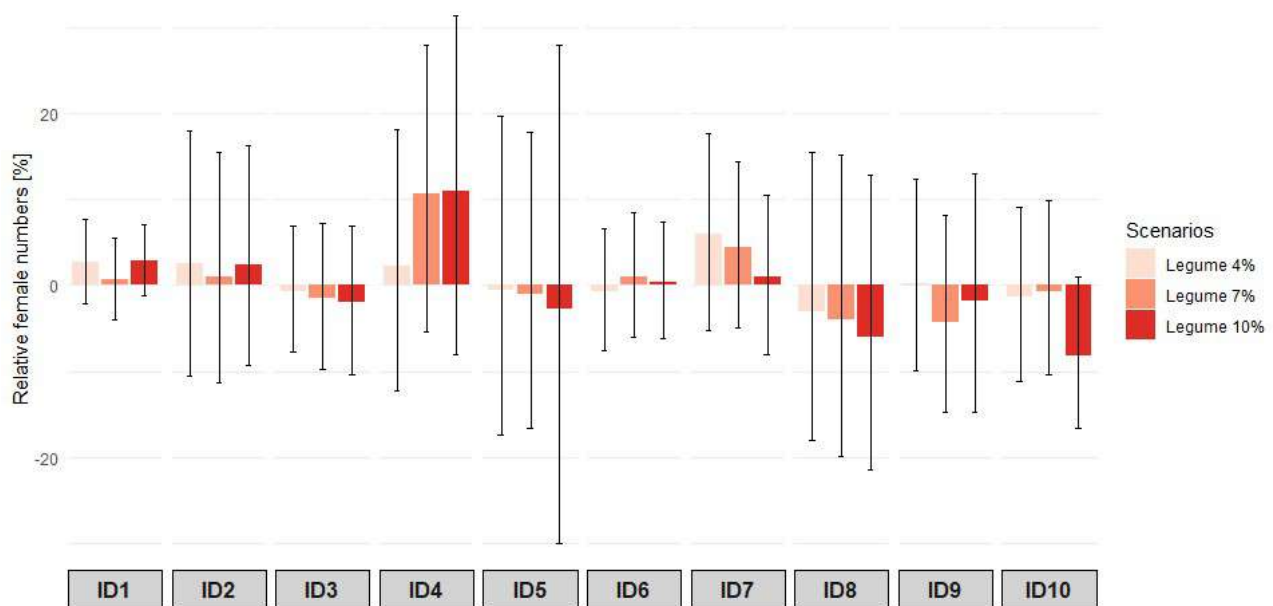


Figure 10.111 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

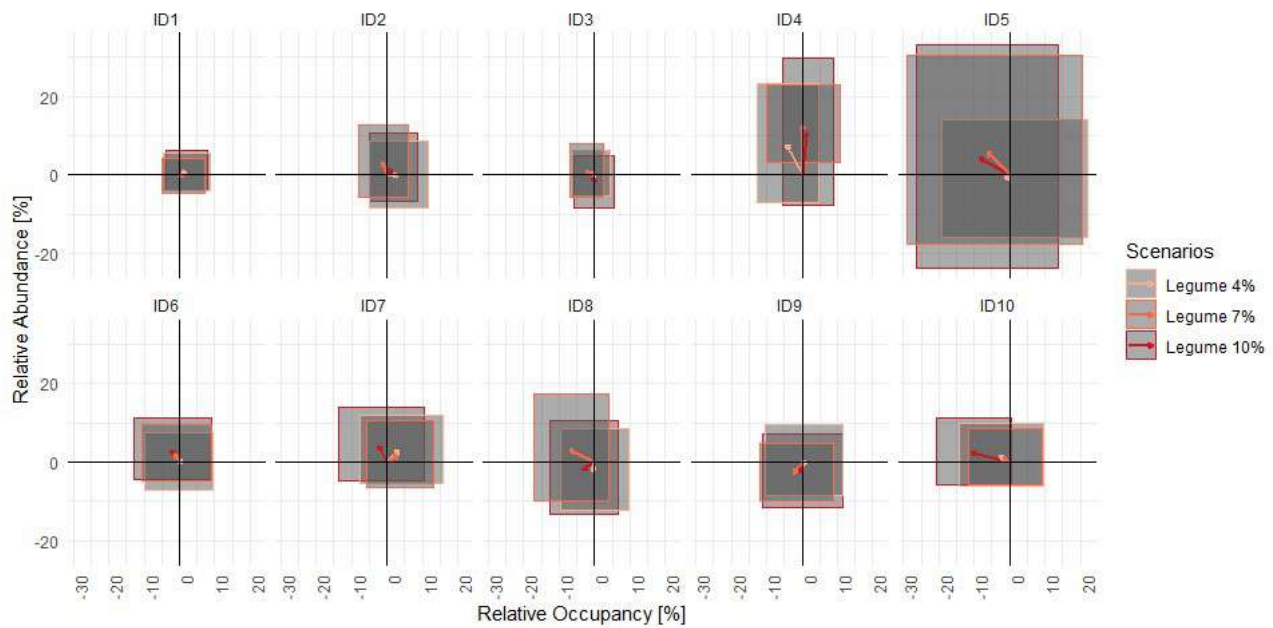


Figure 10.112 Legume scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.7.7 Biopesticides

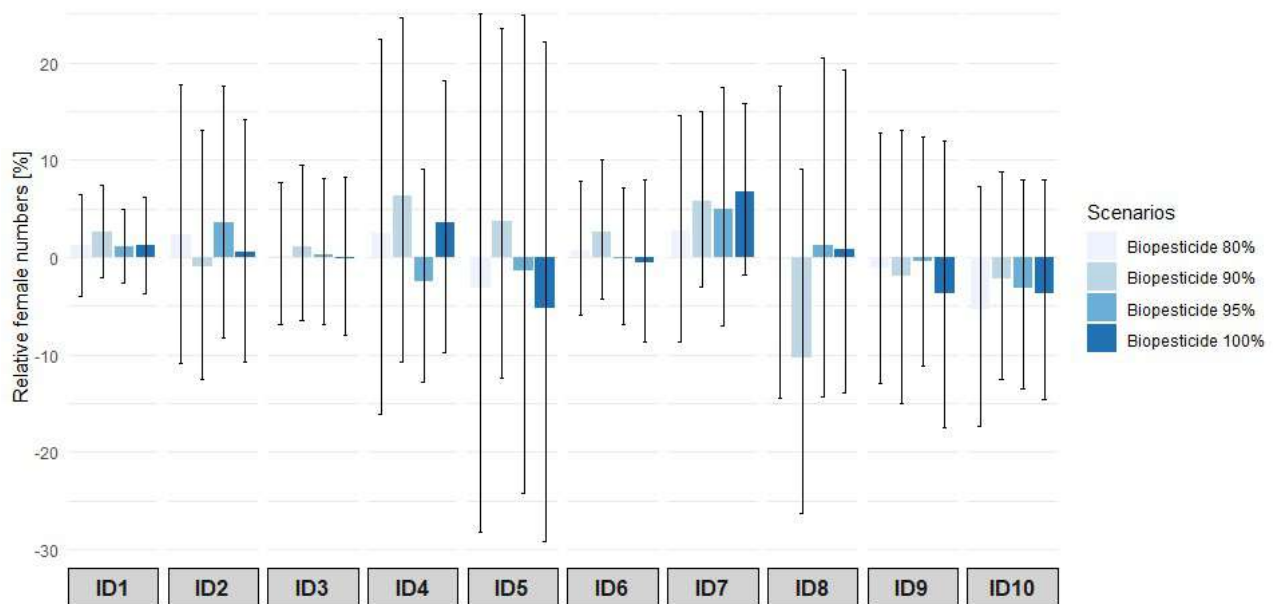


Figure 10.113 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each landscape in the Netherlands.

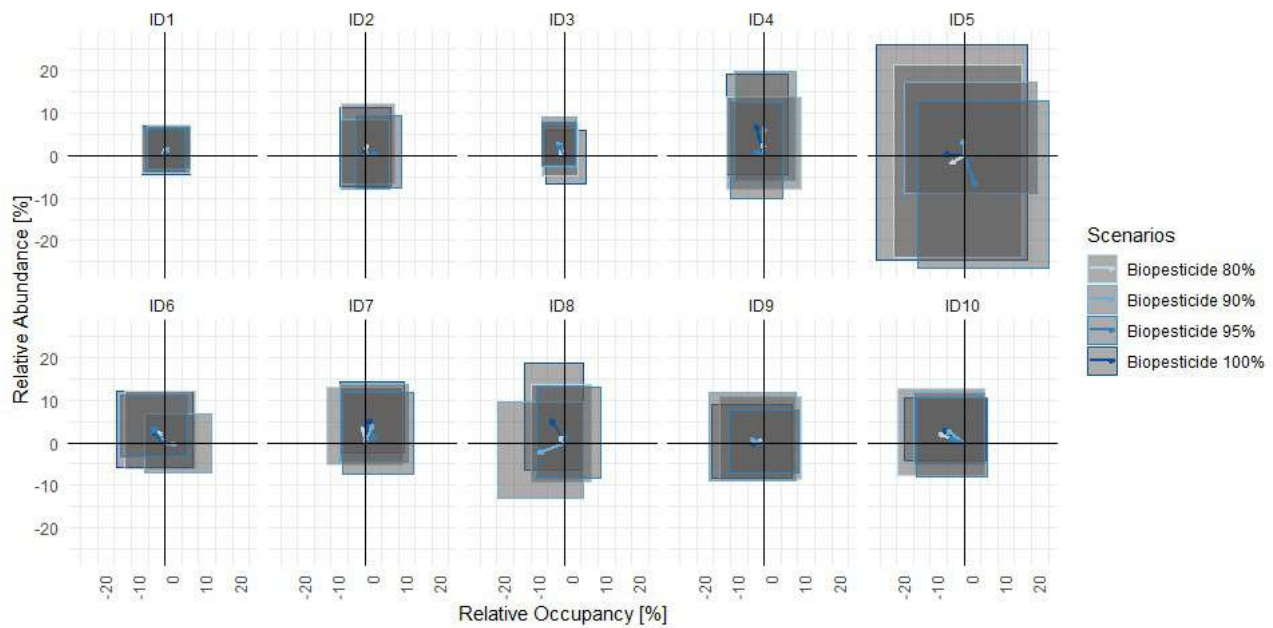


Figure 10.114 Biopesticide scenario with relative change in occupancy and abundance of female Vole compared to baseline $P(0,0)$ for each landscape in the Netherlands at a 400m resolution. Grey areas indicate standard deviation along both axes.

10.8 Combined landscapes

10.8.1 Crop diversification

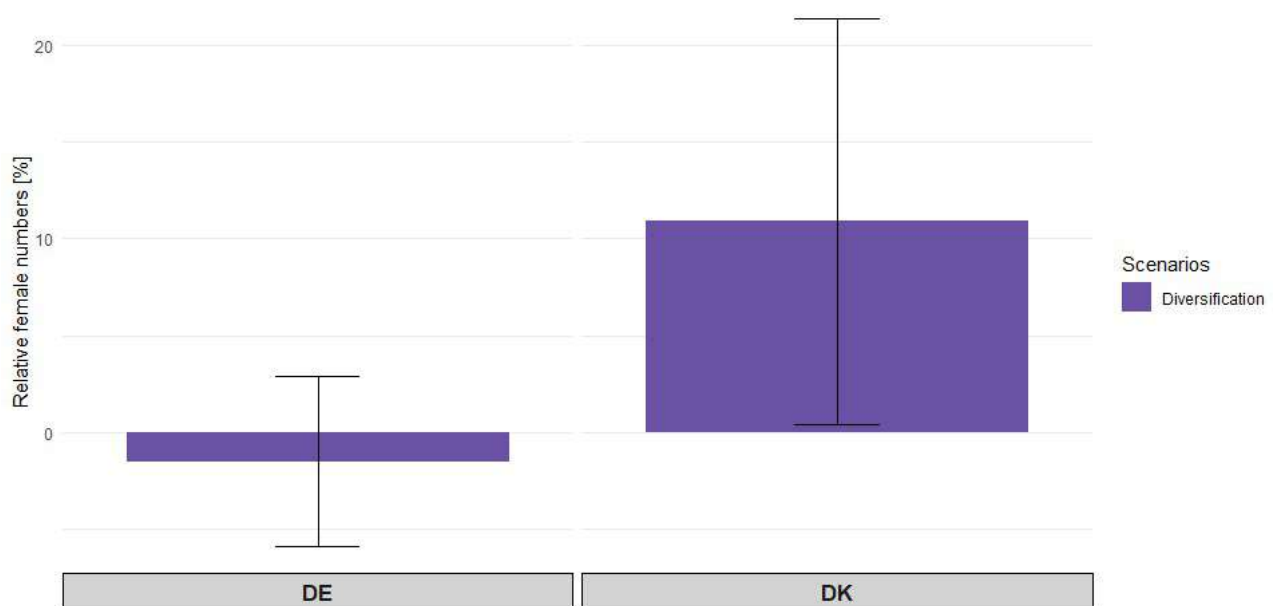


Figure 10.115 Diversification scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

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10.8.2 Flower field margins

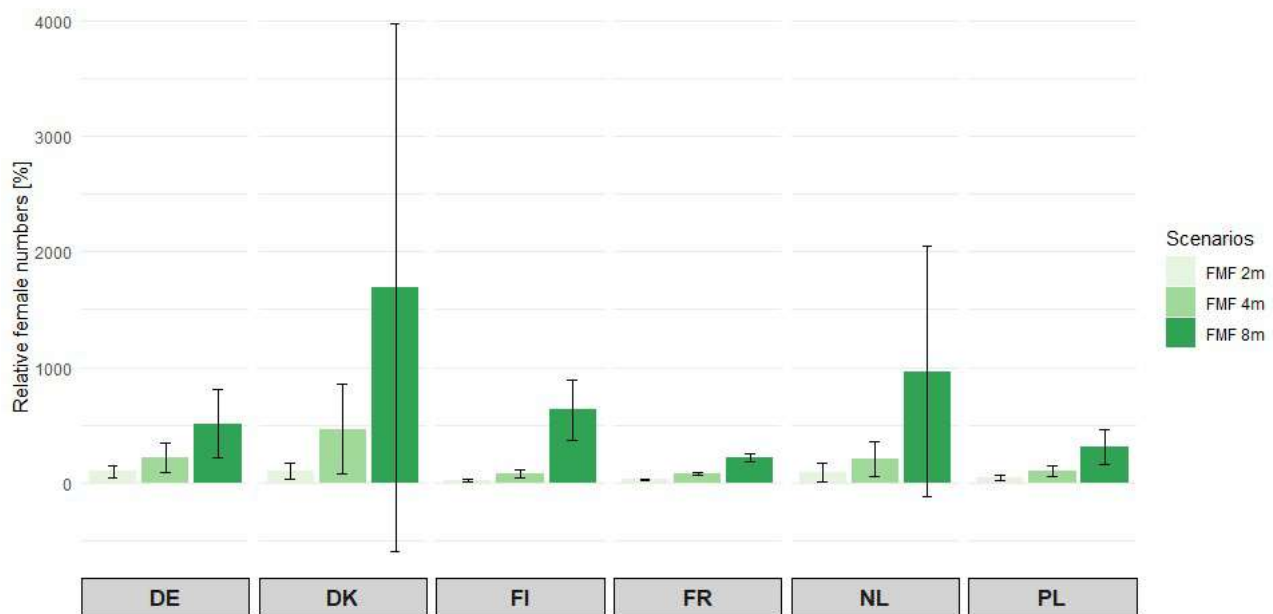


Figure 10.116 Flower field margins with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.3 Grassy field margins

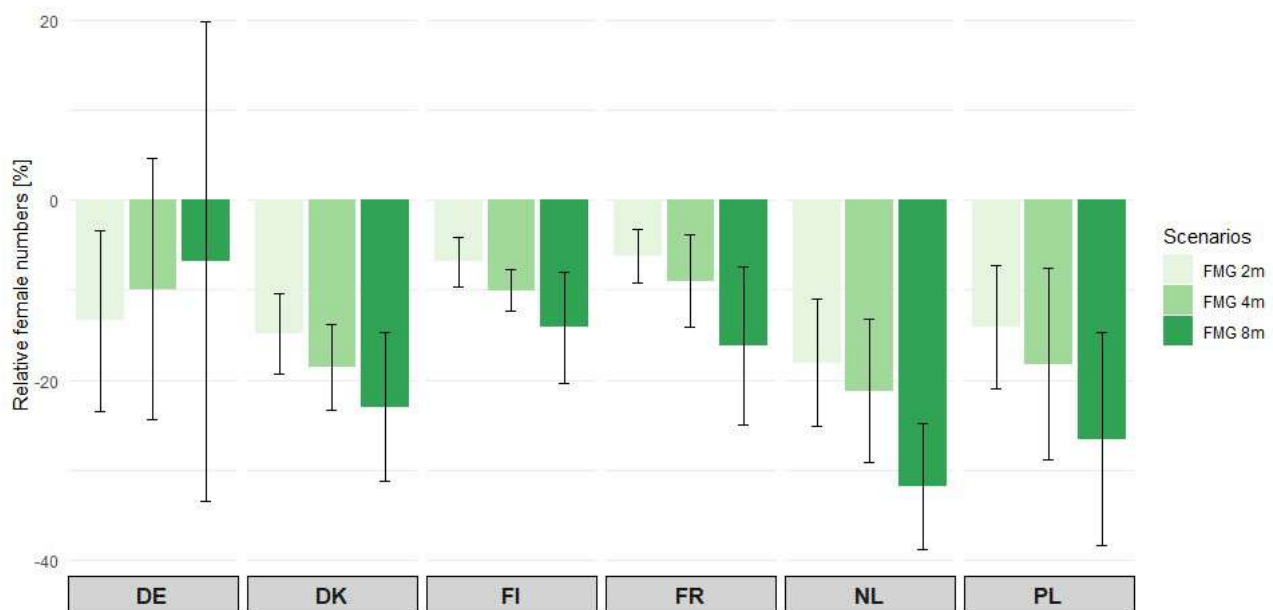


Figure 10.117 Grassy field margins with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.4 Mixed field margins

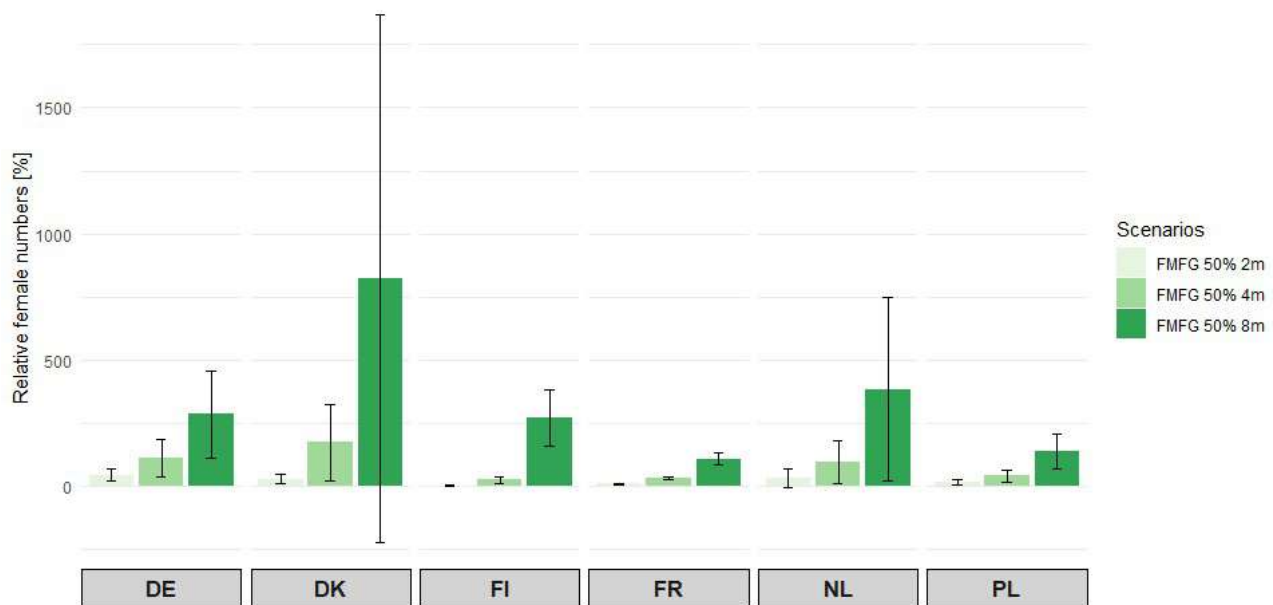


Figure 10.118 Mixed field margins with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.5 Flower, grassy and mixed margins

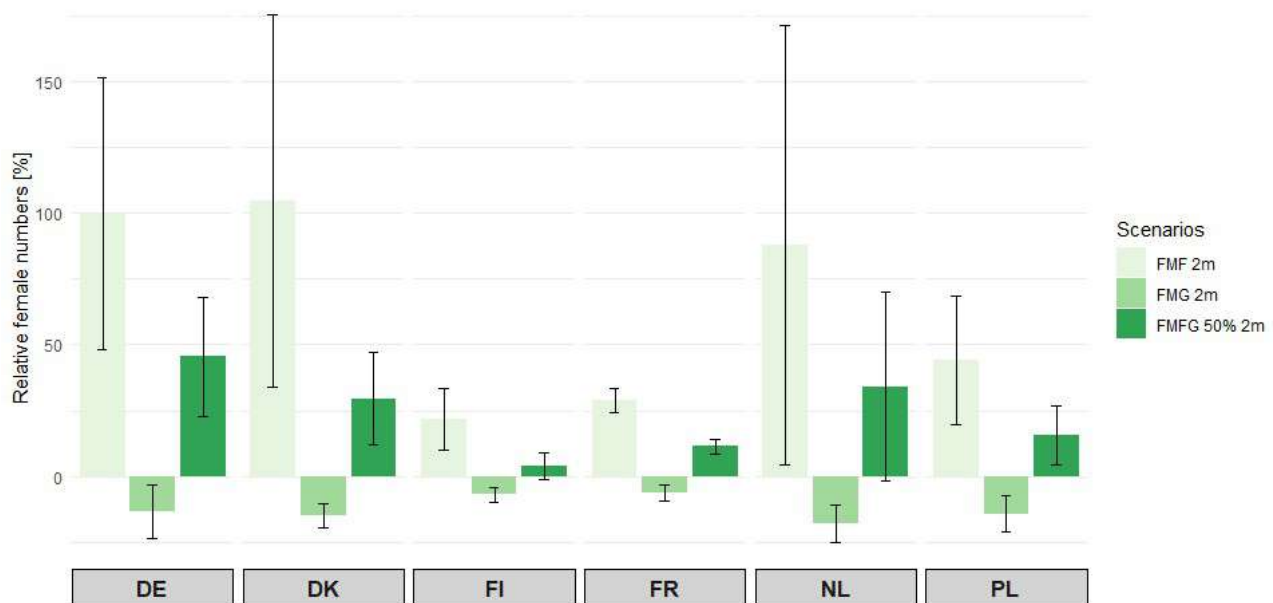


Figure 10.119 Field margins (FM, F: flower, G: grass, FG: mixed) at 2m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

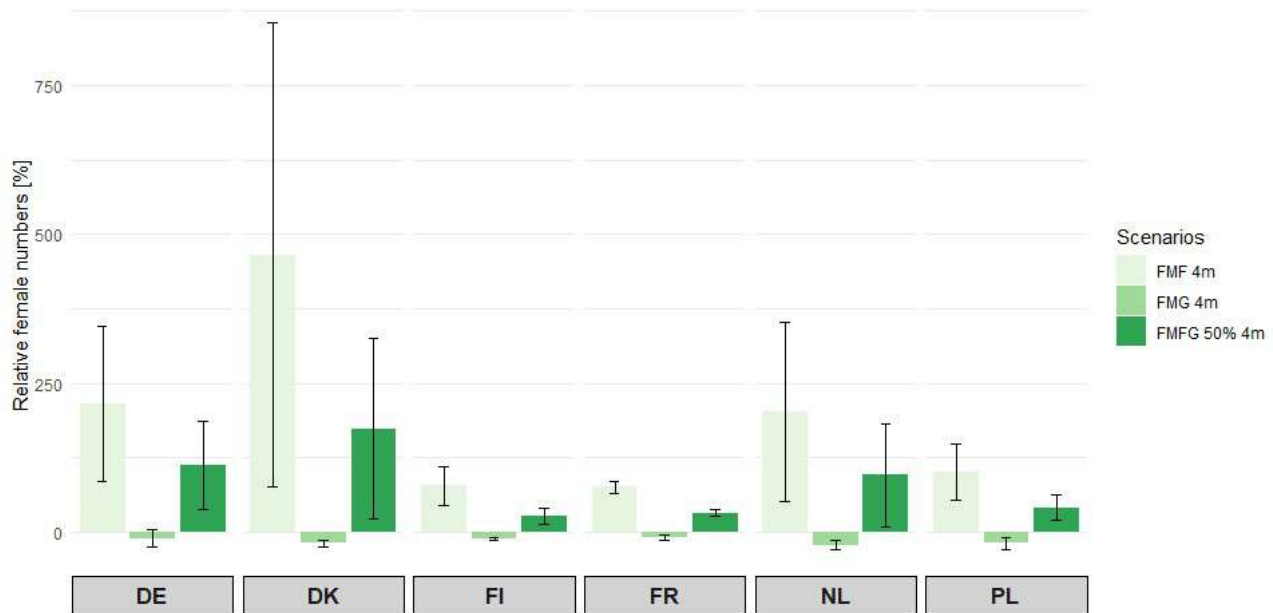


Figure 10.120 Field margins (FM, F: flower, G: grass, FG: mixed) at 4m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

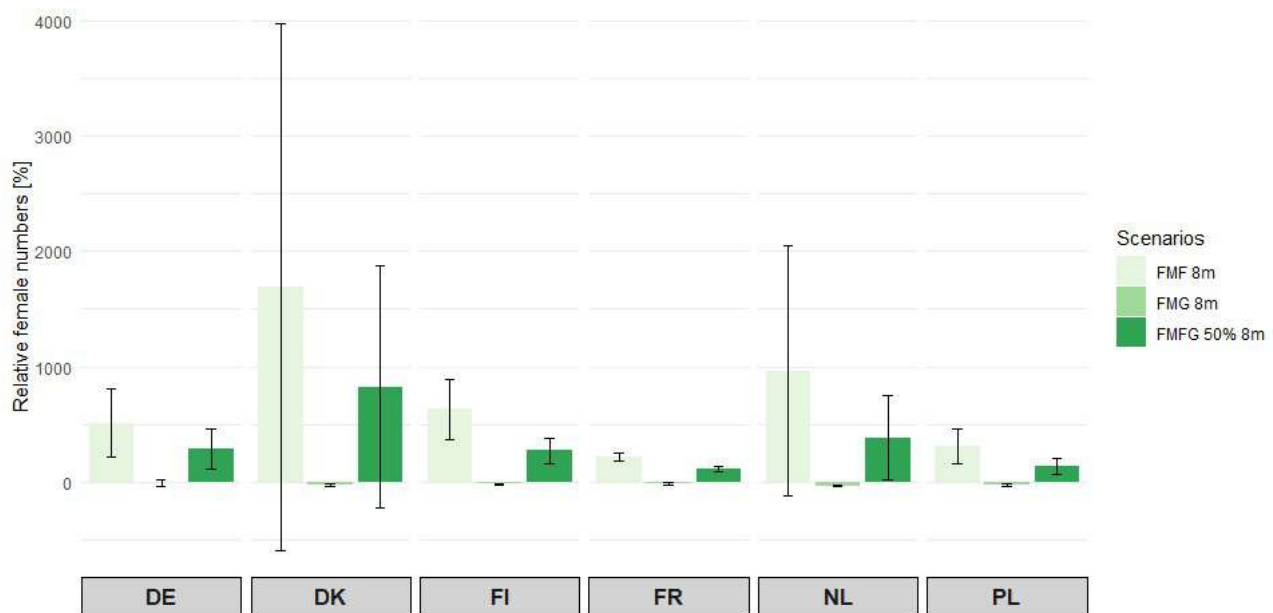


Figure 10.121 Field margins (FM, F: flower, G: grass, FG: mixed) at 8m width with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.6 Setaside

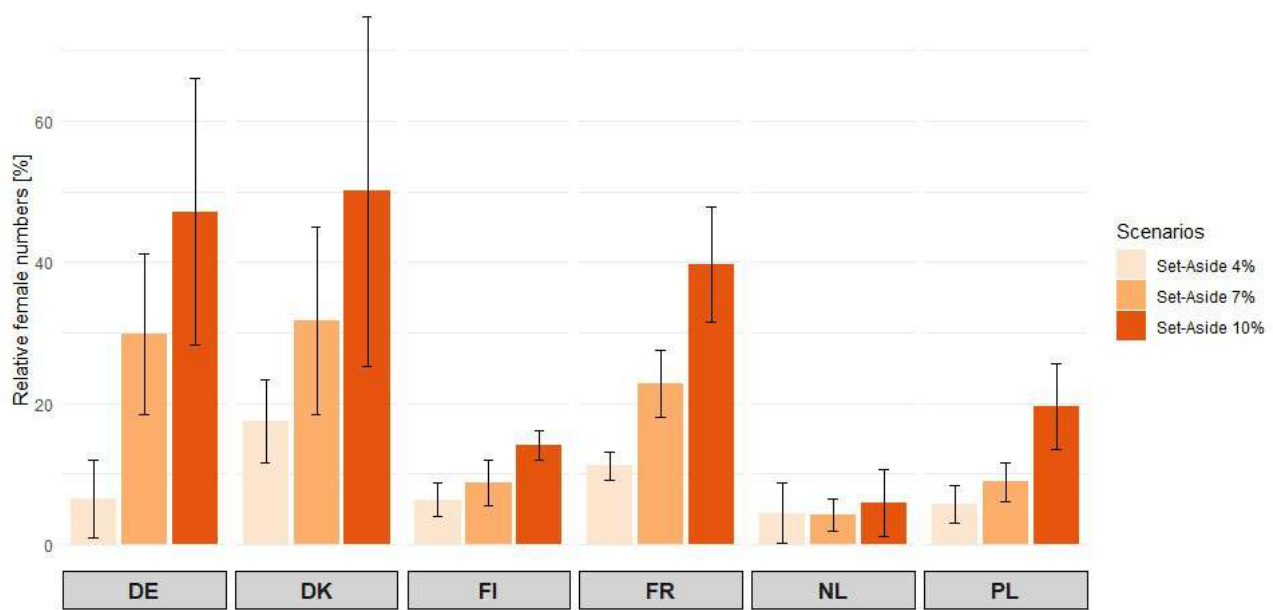


Figure 10.122 Setaside scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.7 Legume

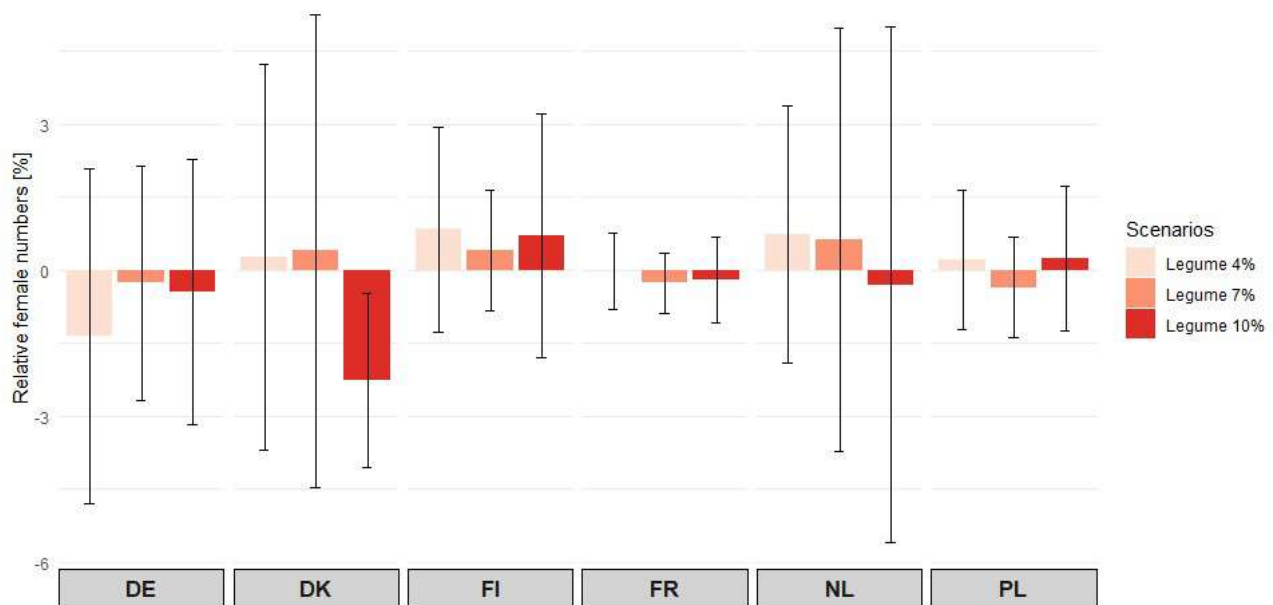


Figure 10.123 Legume scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.8 Biopesticides

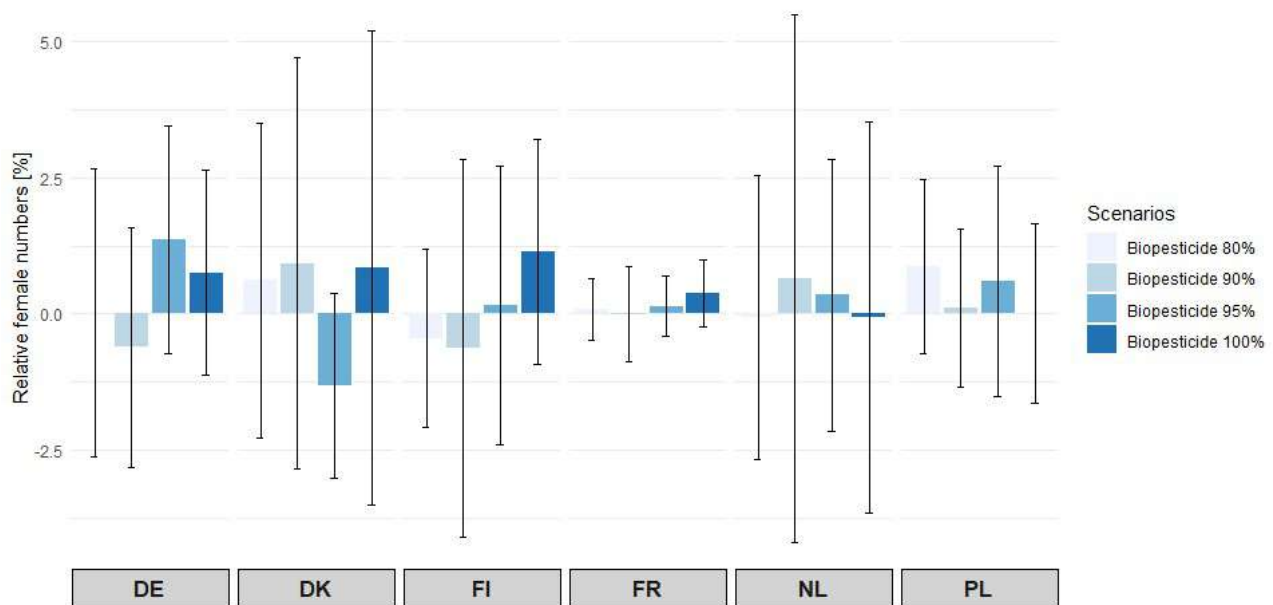


Figure 10.124 Biopesticide scenario with relative change in the number of female Vole compared to baseline and standard deviation presented by error bars for each simulated country.

10.8.9 Table: Country level overview of scenario effects

Table 10.1 Relative change and standard deviation of scenarios compared to the baseline for each county presented in percentages [%] for Vole. Field margin (FM) abbreviations: F; flower field margin, G; grassy field margin, FG; mixed field margin (50% grass, 50% flower).

Scenario	DE	DK	NL	PL	FR	FI
Diversification	-2% (SD 4%)	11% (SD 10%)	NA	NA	NA	NA
FMF 2m	100% (SD 52%)	105% (SD 71%)	88% (SD 83%)	44% (SD 25%)	29% (SD 5%)	22% (SD 12%)
FMF 4m	216% (SD 130%)	466% (SD 391%)	203% (SD 150%)	102% (SD 47%)	76% (SD 10%)	78% (SD 33%)
FMF 8m	510% (SD 297%)	1692% (SD 2286%)	965% (SD 1083%)	309% (SD 150%)	218% (SD 40%)	631% (SD 262%)
FMG 2m	-13% (SD 10%)	-15% (SD 4%)	-18% (SD 7%)	-14% (SD 7%)	-6% (SD 3%)	-7% (SD 3%)
FMG 4m	-10% (SD 14%)	-19% (SD 5%)	-21% (SD 8%)	-18% (SD 11%)	-9% (SD 5%)	-10% (SD 2%)
FMG 8m	-7% (SD 27%)	-23% (SD 8%)	-32% (SD 7%)	-27% (SD 12%)	-16% (SD 9%)	-14% (SD 6%)
FMFG 50% 2m	45% (SD 23%)	29% (SD 18%)	34% (SD 36%)	16% (SD 11%)	11% (SD 3%)	4% (SD 5%)
FMFG 50% 4m	112% (SD 74%)	174% (SD 151%)	96% (SD 86%)	42% (SD 22%)	33% (SD 6%)	27% (SD 14%)

Scenario DE		DK	NL	PL	FR	FI
FMFG	286% (SD 50% 8m 174%)	824% (SD 1046%)	386% (SD 362%)	138% (SD 69%)	109% (SD 23%)	273% (SD 111%)
Set-Aside 4%	7% (SD 6%)	17% (SD 6%)	4% (SD 4%)	6% (SD 3%)	11% (SD 2%)	6% (SD 2%)
Set-Aside 7%	30% (SD 11%)	32% (SD 13%)	4% (SD 2%)	9% (SD 3%)	23% (SD 5%)	9% (SD 3%)
Set-Aside 10%	47% (SD 19%)	50% (SD 25%)	6% (SD 5%)	20% (SD 6%)	40% (SD 8%)	14% (SD 2%)
Legume 4%	-1% (SD 3%)	0% (SD 4%)	1% (SD 3%)	0% (SD 1%)	-0% (SD 1%)	1% (SD 2%)
Legume 7%	-0% (SD 2%)	0% (SD 5%)	1% (SD 4%)	-0% (SD 1%)	-0% (SD 1%)	0% (SD 1%)
Legume 10%	-0% (SD 3%)	-2% (SD 2%)	-0% (SD 5%)	0% (SD 1%)	-0% (SD 1%)	1% (SD 3%)
Bio-pesticide 80%	0% (SD 3%)	1% (SD 3%)	-0% (SD 3%)	1% (SD 2%)	0% (SD 1%)	-0% (SD 2%)
Bio-pesticide 90%	-1% (SD 2%)	1% (SD 4%)	1% (SD 5%)	0% (SD 1%)	-0% (SD 1%)	-1% (SD 3%)
Bio-pesticide 95%	1% (SD 2%)	-1% (SD 2%)	0% (SD 3%)	1% (SD 2%)	0% (SD 1%)	0% (SD 3%)
Bio-pesticide 100%	1% (SD 2%)	1% (SD 4%)	-0% (SD 4%)	0% (SD 2%)	0% (SD 1%)	1% (SD 2%)

11 LANDSCAPE CHARACTERISTICS

11.1 Landscape characteristics

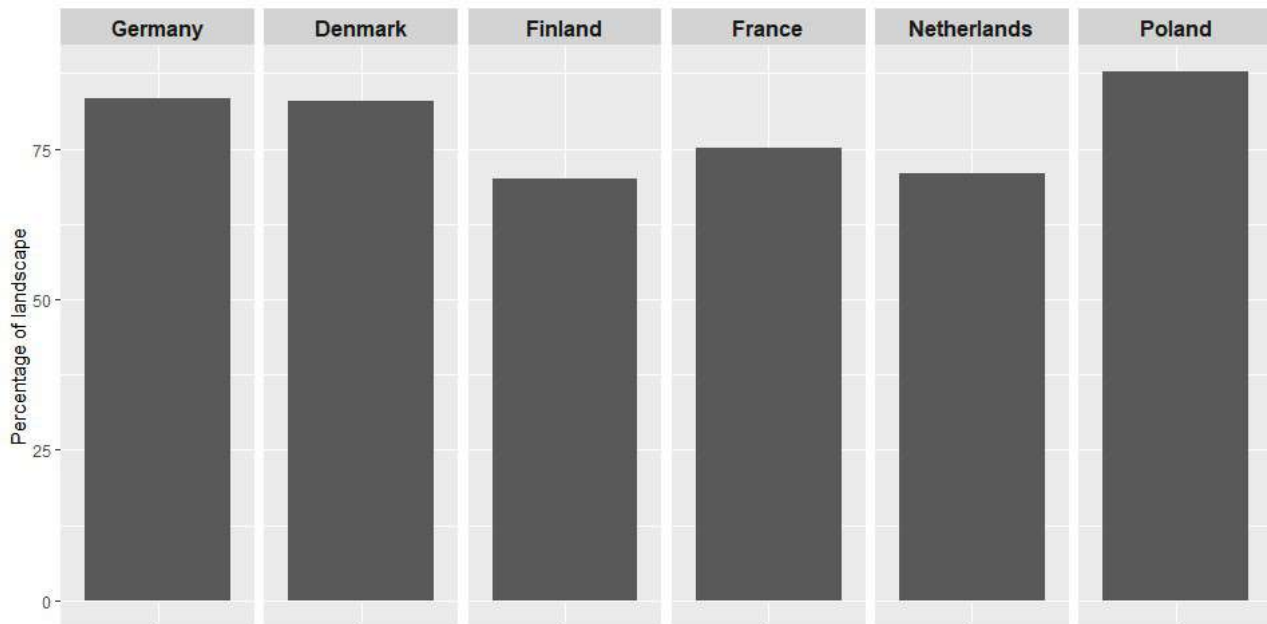


Figure 11.1 Landscape characteristics comparison.

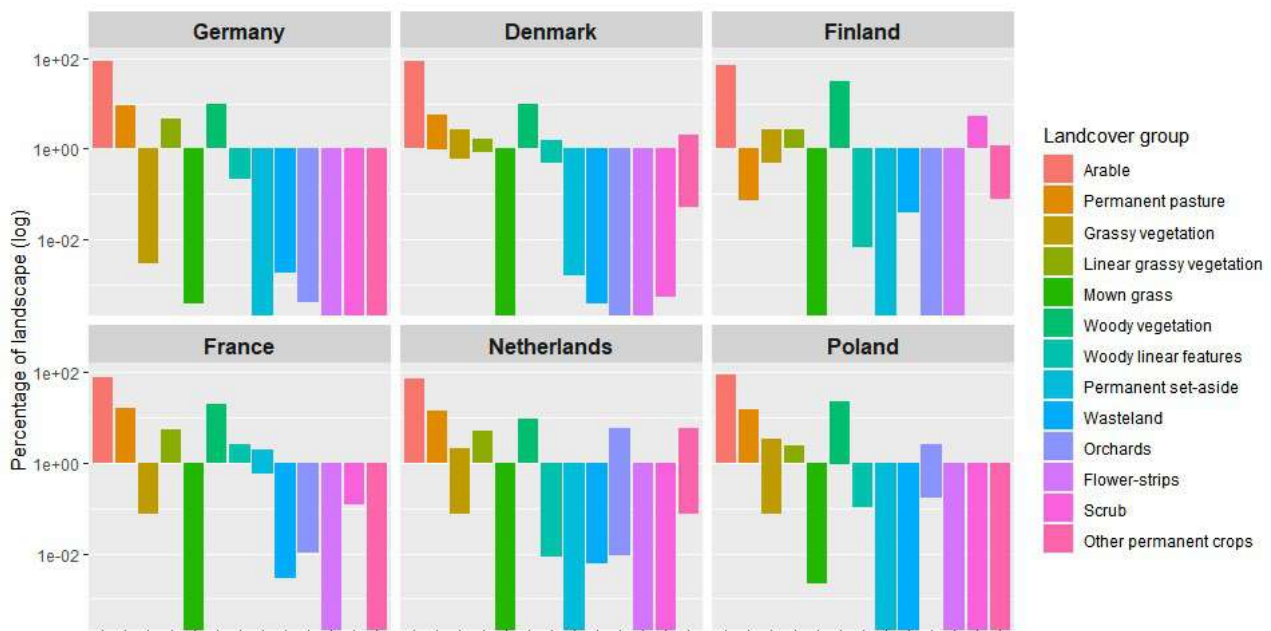


Figure 11.2 Landscape characteristics comparison.

Table 11.1 Relative change of arable area for each scenarios compared to the baseline scenarios for each landscape in each county.

Scenarios	Germany	Denmark	Finland	France	Netherlands	Poland
Diversification	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)
FMF 2m	3% (SD 1%)	4% (SD 1%)	5% (SD 1%)	4% (SD 0%)	4% (SD 1%)	4% (SD 1%)
FMF 4m	5% (SD 2%)	7% (SD 1%)	8% (SD 1%)	8% (SD 0%)	6% (SD 1%)	7% (SD 2%)

Scenarios	Germany	Denmark	Finland	France	Netherlands	Poland
FMF 8m	11% (SD 4%)	13% (SD 2%)	16% (SD 2%)	15% (SD 1%)	13% (SD 2%)	13% (SD 5%)
FMG 2m	3% (SD 1%)	4% (SD 1%)	5% (SD 1%)	4% (SD 0%)	4% (SD 1%)	4% (SD 1%)
FMG 4m	5% (SD 2%)	7% (SD 1%)	8% (SD 1%)	8% (SD 0%)	6% (SD 1%)	7% (SD 2%)
FMG 8m	11% (SD 4%)	13% (SD 2%)	16% (SD 2%)	15% (SD 1%)	13% (SD 2%)	13% (SD 5%)
FMFG 50% 2m	3% (SD 1%)	4% (SD 1%)	5% (SD 1%)	4% (SD 0%)	4% (SD 1%)	4% (SD 1%)
FMFG 50% 4m	5% (SD 2%)	7% (SD 1%)	8% (SD 1%)	8% (SD 0%)	6% (SD 1%)	7% (SD 2%)
FMFG 50% 8m	11% (SD 4%)	13% (SD 2%)	16% (SD 2%)	15% (SD 1%)	13% (SD 2%)	13% (SD 5%)
Set-Aside 4%	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)
Set-Aside 7%	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)
Set-Aside 10%	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)
Legume 4%	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)	4% (SD 0%)
Legume 7%	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)	7% (SD 0%)
Legume 10%	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)	10% (SD 0%)
Biopesticide 80%	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)
Biopesticide 90%	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)
Biopesticide 95%	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)
Biopesticide 100%	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)	0% (SD 0%)

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Table 11.2 Relative change of arable area for each scenarios compared to the baseline scenarios for each county.

Scenario	Relative change
Diversification	0% (SD 0%)
FMF 2m	4% (SD 0%)
FMF 4m	7% (SD 1%)
FMF 8m	13% (SD 1%)
FMG 2m	4% (SD 0%)
FMG 4m	7% (SD 1%)
FMG 8m	13% (SD 1%)
FMFG 50% 2m	4% (SD 0%)
FMFG 50% 4m	7% (SD 1%)
FMFG 50% 8m	13% (SD 1%)

Scenario	Relative change
Set-Aside 4%	4% (SD 0%)
Set-Aside 7%	7% (SD 0%)
Set-Aside 10%	10% (SD 0%)
Legume 4%	4% (SD 0%)
Legume 7%	7% (SD 0%)
Legume 10%	10% (SD 0%)
Biopesticide 80%	0% (SD 0%)
Biopesticide 90%	0% (SD 0%)
Biopesticide 95%	0% (SD 0%)
Biopesticide 100%	0% (SD 0%)

11.2 Area

In this section we look at the effect of the scenarios per percentage change in arable land. In this way we can see how much is gained by adding width or percentage of a field margin or set-aside scenario for different species.

Table 11.3 Relative change of species per percentage area of arable land lost.

Scenarios	Country	Osmia	Oedothorax	Bembidion	Erigone	Skylark	Vole	Hare	Aphid
FMF 2m	DE	0.041	0.14	0.025	0.092	0.35	0.32	0.11	0.012
FMF 4m	DE	0.025	0.14	0.025	0.089	0.22	0.39	0.11	0.018
FMF 8m	DE	0.013	0.13	0.026	0.085	0.15	0.47	0.13	0.014
FMF 2m	DK	0.027	0.12	0.014	0.033	0.090	0.28	0.049	0.012
FMF 4m	DK	0.014	0.11	0.014	0.032	0.055	0.71	0.052	0.0085
FMF 8m	DK	0.0062	0.097	0.015	0.032	0.033	1.3	0.051	0.012
FMF 2m	NL	0.058	NA	NA	NA	0.30	0.23	0.20	NA
FMF 4m	NL	0.037	NA	NA	NA	0.19	0.32	0.21	NA
FMF 8m	NL	0.020	NA	NA	NA	0.11	0.77	0.22	NA
FMF 2m	PL	0.012	0.23	0.033	0.68	0.33	0.11	0.11	NA
FMF 4m	PL	0.0085	0.23	0.032	0.73	0.21	0.15	0.12	NA
FMF 8m	PL	0.0045	0.23	0.033	0.75	0.13	0.23	0.13	NA
FMF 2m	FR	0.038	NA	NA	NA	0.14	0.067	0.082	NA
FMF 4m	FR	0.024	NA	NA	NA	0.089	0.10	0.095	NA

Scenarios	Country	Osmia	Oedothorax	Bembidion	Erigone	Skylark	Vole	Hare	Aphid
FMF 8m	FR	0.013	NA	NA	NA	0.053	0.15	0.093	NA
FMF 2m	FI	0.040	NA	NA	NA	0.062	0.047	0.029	NA
FMF 4m	FI	0.028	NA	NA	NA	0.044	0.098	0.048	NA
FMF 8m	FI	0.016	NA	NA	NA	0.033	0.41	0.066	NA
FMG 2m	DE	0.0027	0.12	0.051	0.084	0.16	-0.043	0.15	0.017
FMG 4m	DE	0.00039	0.11	0.045	0.079	0.096	-0.018	0.18	0.015
FMG 8m	DE	-0.00026	0.10	0.041	0.077	0.060	-0.0063	0.25	0.014
FMG 2m	DK	0.00068	0.089	0.043	0.028	0.043	-0.039	0.071	0.0071
FMG 4m	DK	-0.00068	0.084	0.034	0.028	0.020	-0.028	0.079	0.0083
FMG 8m	DK	-0.0013	0.078	0.026	0.028	0.0038	-0.018	0.098	0.011
FMG 2m	NL	-0.00054	NA	NA	NA	0.17	-0.048	0.27	NA
FMG 4m	NL	-0.0013	NA	NA	NA	0.095	-0.033	0.27	NA
FMG 8m	NL	-0.00065	NA	NA	NA	0.043	-0.025	0.35	NA
FMG 2m	PL	-0.0032	0.19	0.077	0.62	0.20	-0.036	0.19	NA
FMG 4m	PL	-0.00097	0.19	0.063	0.66	0.11	-0.026	0.18	NA 756
FMG 8m	PL	-0.0023	0.19	0.052	0.68	0.040	-0.020	0.23	NA
FMG 2m	FR	0.0012	NA	NA	NA	0.088	-0.014	0.13	NA
FMG 4m	FR	0.00030	NA	NA	NA	0.057	-0.012	0.14	NA
FMG 8m	FR	0.0000044	NA	NA	NA	0.034	-0.011	0.17	NA
FMG 2m	FI	0.00052	NA	NA	NA	0.010	-0.015	0.056	NA
FMG 4m	FI	0.00044	NA	NA	NA	-0.0023	-0.013	0.062	NA
FMG 8m	FI	0.00017	NA	NA	NA	0.00069	-0.0091	0.072	NA
FMFG 50% 2m	DE	0.035	0.13	0.038	0.083	0.26	0.15	0.12	0.015
FMFG 50% 4m	DE	0.023	0.12	0.036	0.084	0.17	0.20	0.14	0.015
FMFG 50% 8m	DE	0.012	0.11	0.034	0.081	0.11	0.26	0.20	0.015
FMFG 50% 2m	DK	0.026	0.10	0.029	0.030	0.070	0.078	0.059	0.0089

Scenarios	Country	Osmia	Oedothorax	Bembidion	Erigone	Skylark	Vole	Hare	Aphid
FMFG 50% 4m	DK	0.013	0.096	0.025	0.030	0.040	0.27	0.056	0.0094
FMFG 50% 8m	DK	0.0067	0.088	0.021	0.030	0.020	0.65	0.077	0.012
FMFG 50% 2m	NL	0.047	NA	NA	NA	0.24	0.089	0.23	NA
FMFG 50% 4m	NL	0.031	NA	NA	NA	0.15	0.15	0.24	NA
FMFG 50% 8m	NL	0.018	NA	NA	NA	0.073	0.31	0.28	NA
FMFG 50% 2m	PL	0.0091	0.21	0.058	0.65	0.26	0.039	0.15	NA
FMFG 50% 4m	PL	0.0063	0.21	0.050	0.69	0.16	0.061	0.15	NA
FMFG 50% 8m	PL	0.0030	0.21	0.044	0.72	0.082	0.10	0.19	NA
FMFG 50% 2m	FR	0.030	NA	NA	NA	0.12	0.026	0.10	NA
FMFG 50% 4m	FR	0.020	NA	NA	NA	0.074	0.043	0.12	NA
FMFG 50% 8m	FR	0.012	NA	NA	NA	0.046	0.073	0.13	NA
FMFG 50% 2m	FI	0.030	NA	NA	NA	0.045	0.0084	0.049	NA
FMFG 50% 4m	FI	0.022	NA	NA	NA	0.025	0.034	0.063	NA
FMFG 50% 8m	FI	0.014	NA	NA	NA	0.018	0.18	0.068	NA
Set-Aside 4%	DE	0.0016	0.053	0.014	0.053	0.22	0.016	0.12	0.0052
Set-Aside 7%	DE	0.0019	0.064	0.017	0.067	0.32	0.043	0.15	0.013
Set-Aside 10%	DE	0.000056	0.067	0.017	0.068	0.31	0.047	0.18	0.0096
Set-Aside 4%	DK	0.0012	0.059	0.0053	0.028	0.034	0.044	0.074	0.022

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Scenarios	Country	Osmia	Oedothorax	Bembidion	Erigone	Skylark	Vole	Hare	Aphid
Set-Aside 7%	DK	0.0020	0.050	0.0055	0.025	0.034	0.045	0.073	0.019
Set-Aside 10%	DK	0.0010	0.050	0.0056	0.024	0.036	0.050	0.077	0.018
Set-Aside 4%	NL	0.0011	NA	NA	NA	0.094	0.011	0.11	NA
Set-Aside 7%	NL	0.0015	NA	NA	NA	0.096	0.0059	0.10	NA
Set-Aside 10%	NL	0.00083	NA	NA	NA	0.094	0.0059	0.13	NA
Set-Aside 4%	PL	-0.0013	0.071	0.022	0.82	0.22	0.014	0.17	NA
Set-Aside 7%	PL	-0.000076	0.072	0.021	0.78	0.19	0.013	0.17	NA
Set-Aside 10%	PL	0.000014	0.091	0.025	0.82	0.17	0.020	0.22	NA
Set-Aside 4%	FR	0.0058	NA	NA	NA	0.19	0.028	0.13	NA
Set-Aside 7%	FR	0.0051	NA	NA	NA	0.18	0.033	0.12	NA
Set-Aside 10%	FR	0.0047	NA	NA	NA	0.18	0.040	0.13	NA
Set-Aside 4%	FI	0.0080	NA	NA	NA	0.071	0.016	0.041	NA
Set-Aside 7%	FI	0.0077	NA	NA	NA	0.067	0.012	0.054	NA
Set-Aside 10%	FI	0.0067	NA	NA	NA	0.065	0.014	0.054	NA
Legume 4%	DE	0.0023	0.0038	-0.00023	0.0030	0.098	-0.0034	0.056	0.0091
Legume 7%	DE	0.0013	0.00075	0.0024	0.00096	0.11	-0.00038	0.061	0.0087
Legume 10%	DE	0.00020	0.0015	0.0012	0.0030	0.13	-0.00044	0.072	0.0051
Legume 4%	DK	0.0013	-0.0081	-0.00062	-0.0056	0.017	0.00066	0.034	-0.013

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Scenarios	Country	Osmia	Oedothorax	Bembidion	Erigone	Skylark	Vole	Hare	Aphid
Legume 7%	DK	0.00032	-0.0086	-0.00029	-0.0060	0.016	0.00056	0.034	-0.012
Legume 10%	DK	0.00050	-0.011	-0.00089	-0.0078	0.017	-0.0023	0.032	- 0.0095
Legume 4%	NL	0.000019	NA	NA	NA	0.055	0.0018	0.064	NA
Legume 7%	NL	-0.00061	NA	NA	NA	0.054	0.00089	0.056	NA
Legume 10%	NL	-0.00054	NA	NA	NA	0.061	-0.00030	0.061	NA
Legume 4%	PL	-0.0021	-0.0046	0.0042	-0.023	-0.041	0.00052	- 0.00049	NA
Legume 7%	PL	0.00059	-0.0037	0.0039	-0.025	-0.039	-0.00052	0.0016	NA
Legume 10%	PL	-0.0014	-0.0053	0.0034	-0.026	-0.038	0.00023	0.015	NA
Legume 4%	FR	0.0012	NA	NA	NA	0.023	- 0.000054	0.070	NA
Legume 7%	FR	0.00084	NA	NA	NA	0.025	-0.00038	0.070	NA
Legume 10%	FR	0.00025	NA	NA	NA	0.031	-0.00021	0.080	NA
Legume 4%	FI	0.00024	NA	NA	NA	-0.014	0.0021	-0.0090	NA
Legume 7%	FI	0.00023	NA	NA	NA	-0.011	0.00059	-0.0056	NA
Legume 10%	FI	0.00043	NA	NA	NA	-0.014	0.00071	-0.0070	NA

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Figure 11.3 Relative change in species abundance caused by scenarios, divided by percentage area of arable land. The bars increase with 2m, 4m, or 8m for those scenarios beginning FM and 4%, 7% and 10% for the Legumes and Set-Aside.

12 MULTI-CRITERIA COST-BENEFIT ANALYSIS

Without weighting the individual species, the top scenarios look like those in the figure below.

Table 12.1 Summed classification for each country and scenario across species, not weighted for species and cost.

Scenarios	DE	DK
Diversification	-0.15	-0.03
FMF 2m	0.42	0.29
FMF 4m	0.70	0.82
FMF 8m	1.38	2.51
FMG 2m	0.21	0.11
FMG 4m	0.35	0.18
FMG 8m	0.72	0.36
FMFG 50% 2m	0.32	0.19
FMFG 50% 4m	0.54	0.44
FMFG 50% 8m	1.12	1.44
Set-Aside 4%	0.24	0.13
Set-Aside 7%	0.60	0.22
Set-Aside 10%	0.88	0.33
Legume 4%	0.08	0.01
Legume 7%	0.16	0.02
Legume 10%	0.26	0.02
Biopesticide 80%	0.04	0.02
Biopesticide 90%	0.06	0.02
Biopesticide 95%	0.06	0.03
Biopesticide 100%	0.07	0.03

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With the countries remaining separate, each could have their own stacking scenario. But if we are looking for one stacked scenario, then averaging the countries also makes sense. Countries can still be weighted, however. In this case we have only included Denmark and Germany, as the beetle and spider simulations were not run for the other countries.

Table 12.2 Summed classification for each scenario across species, with the weighting for species and cost weighting.

Scenarios	Value
Diversification	-0.07
FMF 2m	0.36
FMF 4m	0.76
FMF 8m	1.94
FMG 2m	0.16
FMG 4m	0.26
FMG 8m	0.54
FMFG 50% 2m	0.26
FMFG 50% 4m	0.49
FMFG 50% 8m	1.28
Set-Aside 4%	0.19
Set-Aside 7%	0.41
Set-Aside 10%	0.60
Legume 4%	0.05
Legume 7%	0.09
Legume 10%	0.14
Biopesticide 80%	0.03
Biopesticide 90%	0.04
Biopesticide 95%	0.04
Biopesticide 100%	0.05

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Without any weighting, an 8m field margin with flowers (FMF 8m) stands out as a clear winner. This could be combined with 4% Set-Aside in a stacked scenario. However, this does not account for the additional cost an 8m wide strip over a 2m or 4m strip. If we add a cost weight by the width of the strips and the percentage area, so that 2m is 1, 4m is 2, and 8m is 4. And so that 4% is 1, 7% is 1.75 and 10% is 2.5, not accounting at this stage for the actual areas that may be covered in landscapes but using a qualitative measure. The cost divides the relative increase. This is again included in Denmark, Germany, and Poland, as the Bembidion and spider (Oedothorax and Erigone) simulations were not run for the other countries.

Table 12.3 Summed classification for each scenario across species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	-0.09
FMF 2m	0.36
FMF 4m	0.38
FMF 8m	0.49
FMG 2m	0.16
FMG 4m	0.13
FMG 8m	0.13
FMFG 50% 2m	0.26
FMFG 50% 4m	0.25
FMFG 50% 8m	0.32
Set-Aside 4%	0.19
Set-Aside 7%	0.23
Set-Aside 10%	0.24
Legume 4%	0.05
Legume 7%	0.05
Legume 10%	0.06
Biopesticide 80%	0.03
Biopesticide 90%	0.04
Biopesticide 95%	0.04
Biopesticide 100%	0.05

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This does not take into consideration the aim of increasing the number of each species. With the current weighting the aim is simply to increase each species modelled by the greatest proportion. However, if the objective is to increase the services provided by certain groups of species, if we just include the invertebrates, we have three pest controlling species (Aphids, Oedothorax, Erigone and Bembidion) and one pollinator (Osmia). Again, only included Denmark, Germany and Poland, as the beetle and spider simulations were not run for the other countries. If we divide the weight of the three predators by 4, so that each service is equally represented. The top scenario switches to a 2m field margin with flowers and 4% set aside.

Table 12.4 Summed classification for each scenario across species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	0.01
FMF 2m	0.05
FMF 4m	0.03
FMF 8m	0.02
FMG 2m	0.03
FMG 4m	0.02
FMG 8m	0.02
FMFG 50% 2m	0.05
FMFG 50% 4m	0.03
FMFG 50% 8m	0.02
Set-Aside 4%	0.02
Set-Aside 7%	0.02
Set-Aside 10%	0.02
Legume 4%	0.00
Legume 7%	0.00
Legume 10%	0.00
Biopesticide 80%	0.01
Biopesticide 90%	0.02
Biopesticide 95%	0.02
Biopesticide 100%	0.02

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We can do the same thing for the vertebrate species, but with each treated equally. And in this case include all countries.

Table 12.5 Summed classification for each scenario across vertebrate species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	-0.22
FMF 2m	0.60
FMF 4m	0.58
FMF 8m	0.82
FMG 2m	0.28
FMG 4m	0.21
FMG 8m	0.22
FMFG 50% 2m	0.44
FMFG 50% 4m	0.39
FMFG 50% 8m	0.51
Set-Aside 4%	0.35
Set-Aside 7%	0.38
Set-Aside 10%	0.41
Legume 4%	0.08
Legume 7%	0.08
Legume 10%	0.10
Biopesticide 80%	0.01
Biopesticide 90%	0.00
Biopesticide 95%	0.01
Biopesticide 100%	0.01

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12.1 Weighting by landscape characteristics

If we take the actual percentage reduction in area (or in fact one minus the reduction) this gives a much better indication of how much arable land is lost from production (not accounting for the nitrogen enhancement of legumes) with each scenario. Again, just for Denmark, Germany, and Poland. Adding this cost alone, and no weighting my species more is gained by wider strips than is lost in land.

Table 12.6 Summed classification for each scenario across species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	-0.09
FMF 2m	0.34
FMF 4m	0.71
FMF 8m	1.68
FMG 2m	0.15
FMG 4m	0.25
FMG 8m	0.47
FMFG 50% 2m	0.25
FMFG 50% 4m	0.46
FMFG 50% 8m	1.11
Set-Aside 4%	0.18
Set-Aside 7%	0.38
Set-Aside 10%	0.54
Legume 4%	0.05
Legume 7%	0.08
Legume 10%	0.13
Biopesticide 80%	0.03
Biopesticide 90%	0.04
Biopesticide 95%	0.04
Biopesticide 100%	0.05

For invertebrates weighted like before, with the spiders and beetles weighted down.

Table 12.7 Summed classification for each scenario across species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	0.01
FMF 2m	0.05
FMF 4m	0.06
FMF 8m	0.08
FMG 2m	0.02
FMG 4m	0.04
FMG 8m	0.06
FMFG 50% 2m	0.05
FMFG 50% 4m	0.06
FMFG 50% 8m	0.08
Set-Aside 4%	0.02
Set-Aside 7%	0.03
Set-Aside 10%	0.04
Legume 4%	0.00
Legume 7%	0.00
Legume 10%	0.00
Biopesticide 80%	0.01
Biopesticide 90%	0.02
Biopesticide 95%	0.02
Biopesticide 100%	0.02

For invertebrates equally weighted:

Table 12.8 Summed classification for each scenario across species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	0.01
FMF 2m	0.10
FMF 4m	0.15
FMF 8m	0.25
FMG 2m	0.09
FMG 4m	0.14
FMG 8m	0.24
FMFG 50% 2m	0.11
FMFG 50% 4m	0.16
FMFG 50% 8m	0.26
Set-Aside 4%	0.06
Set-Aside 7%	0.12
Set-Aside 10%	0.16
Legume 4%	0.00
Legume 7%	0.00
Legume 10%	-0.01
Biopesticide 80%	0.04
Biopesticide 90%	0.06
Biopesticide 95%	0.06
Biopesticide 100%	0.06

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For vertebrates unweighted like before.

Table 12.9 Summed classification for each scenario across species, with the weighting the cost based on assuming multiplicative costs of width of field margin or percentage fields changed to set-aside or legumes.

Scenarios	Value
Diversification	-0.22
FMF 2m	0.58
FMF 4m	1.09
FMF 8m	2.83
FMG 2m	0.27
FMG 4m	0.40
FMG 8m	0.78
FMFG 50% 2m	0.42
FMFG 50% 4m	0.72
FMFG 50% 8m	1.78
Set-Aside 4%	0.34
Set-Aside 7%	0.62
Set-Aside 10%	0.92
Legume 4%	0.08
Legume 7%	0.13
Legume 10%	0.22
Biopesticide 80%	0.01
Biopesticide 90%	0.00
Biopesticide 95%	0.01
Biopesticide 100%	0.01

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Table 12.10 Unweighted mean relative change of species numbers for treatment scenarios compared to baseline scenario. The unweighted category is simple the mean of all species. Arable weights the means by the percentage reduction of arable land compared to the baseline. Arable Weighted Invertebrate, combines Oedothorax, Bembidion, Erigone and aphids (multiplied by -1) into a single group, by dividing all four, by four. Arable Invertebrate and Arable Vertebrate are the species split into those groups, but not weighted further.

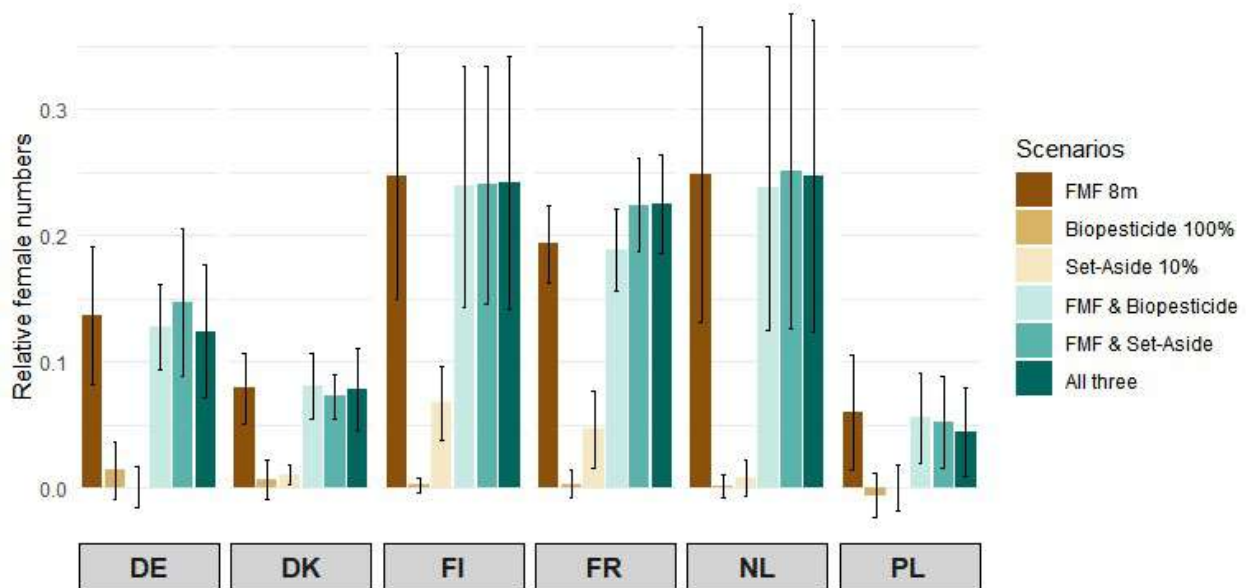
Scenarios	Unweighted	Arable	Arable Weighted Invertebrate	Arable Invertebrate	Arable Vertebrate	
Diversification	-0.07	-0.09	0.01	0.01	-0.22	
FMF 2m	0.36	0.34	0.05	0.10	0.58	
FMF 4m	0.76	0.71	0.06	0.15	1.09	
FMF 8m	1.94	1.68	0.08	0.25	2.83	
FMG 2m	0.16	0.15	0.02	0.09	0.27	
FMG 4m	0.26	0.25	0.04	0.14	0.40	
FMG 8m	0.54	0.47	0.06	0.24	0.78	
FMFG 50% 2m	0.26	0.25	0.05	0.11	0.42	
FMFG 50% 4m	0.49	0.46	0.06	0.16	0.72	
FMFG 50% 8m	1.28	1.11	0.08	0.26	1.78	
Set-Aside 4%	0.19	0.18	0.02	0.06	0.34	770
Set-Aside 7%	0.41	0.38	0.03	0.12	0.62	
Set-Aside 10%	0.60	0.54	0.04	0.16	0.92	
Legume 4%	0.05	0.05	0.00	0.00	0.08	
Legume 7%	0.09	0.08	0.00	0.00	0.13	
Legume 10%	0.14	0.13	0.00	-0.01	0.22	
Biopesticide 80%	0.03	0.03	0.01	0.04	0.01	
Biopesticide 90%	0.04	0.04	0.02	0.06	0.00	
Biopesticide 95%	0.04	0.04	0.02	0.06	0.01	
Biopesticide 100%	0.05	0.05	0.02	0.06	0.01	
Hypothetical optimum stack 2 FMF set-aside	2.54	2.22	0.12	0.41	3.75	
Hypothetical optimum stack 2 FMF biopesticide	1.99	1.73	0.10	0.31	2.84	
Hypothetical optimum stack 3 all three	2.59	2.27	0.14	0.47	3.76	

13 STACKED SCENARIOS

Component scenarios were not run for all species in all countries, but baselines and stacking scenarios were. Where component scenarios were not run in the country, the country has not been included when combining the countries together. This allows for comparison between the effects of the stacking scenario to the component scenario in the countries where they are comparable. When comparing between different stacking scenario, the results from the other countries were re-included, i.e. these include all countries.

13.1 Osmia

13.1.1 Maximum uptake scenario



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Figure 13.1 Osmia maximum uptake stacking scenarios chart showing relative numbers of female Osmia in each scenario compared to the baseline in each country.

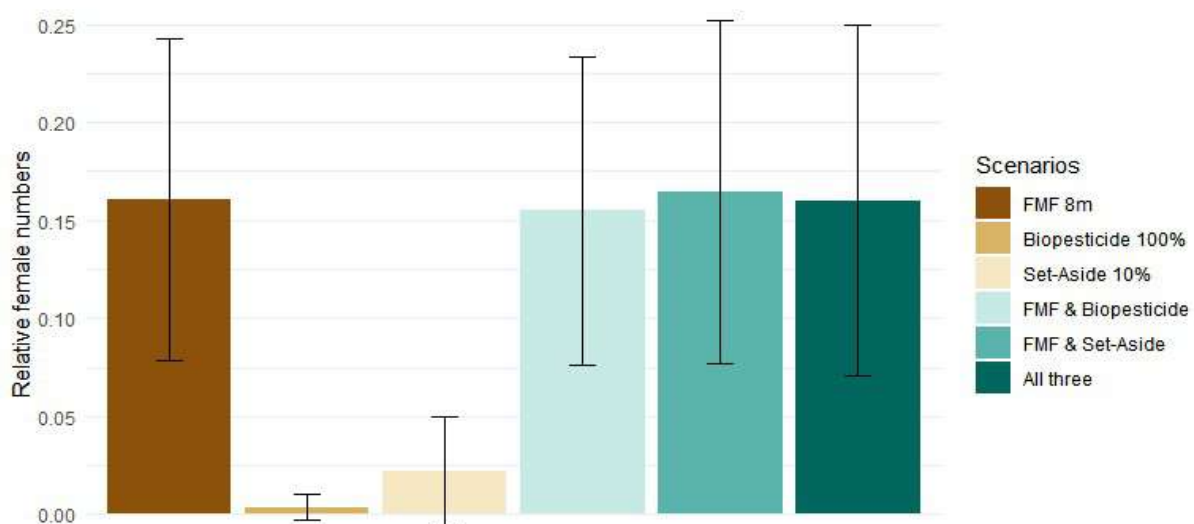


Figure 13.2 Osmia maximum uptake stacking scenarios chart showing relative numbers of female Osmia in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.1 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMF 8m	16%	8%
Biopesticide 100%	0%	1%
Set-Aside 10%	2%	3%
FMF & Biopesticide	15%	8%
FMF & Set-Aside	16%	9%
All three	16%	9%

13.1.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

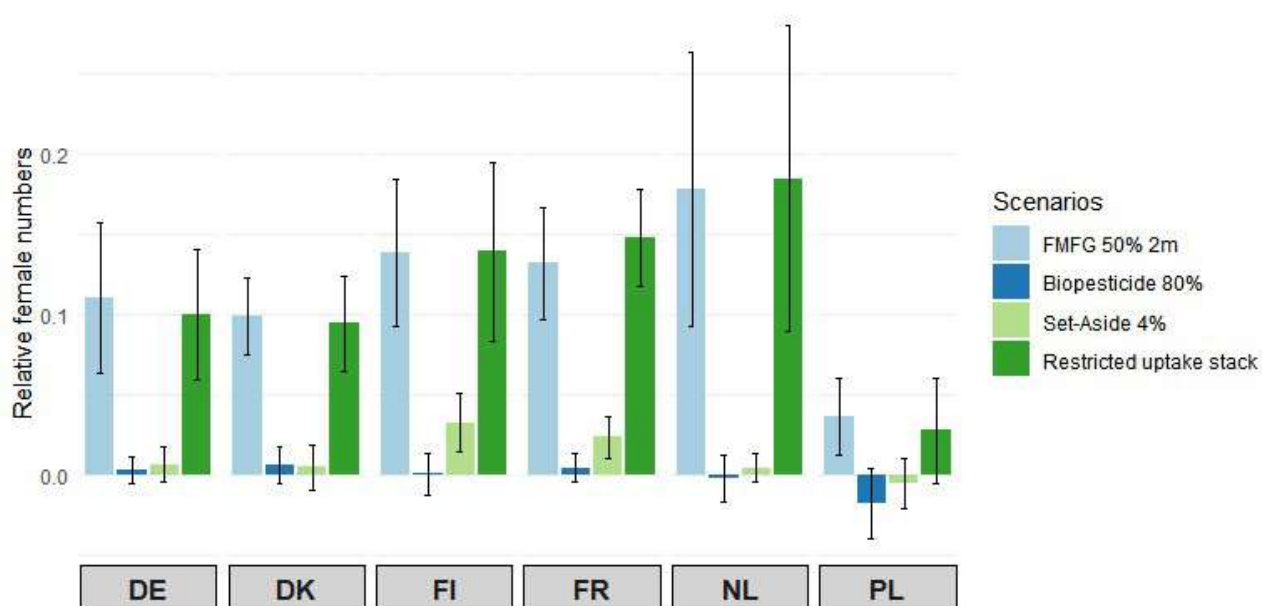


Figure 13.3 Osmia restricted uptake stacking scenario and component scenarios showing relative numbers of female Osmia in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

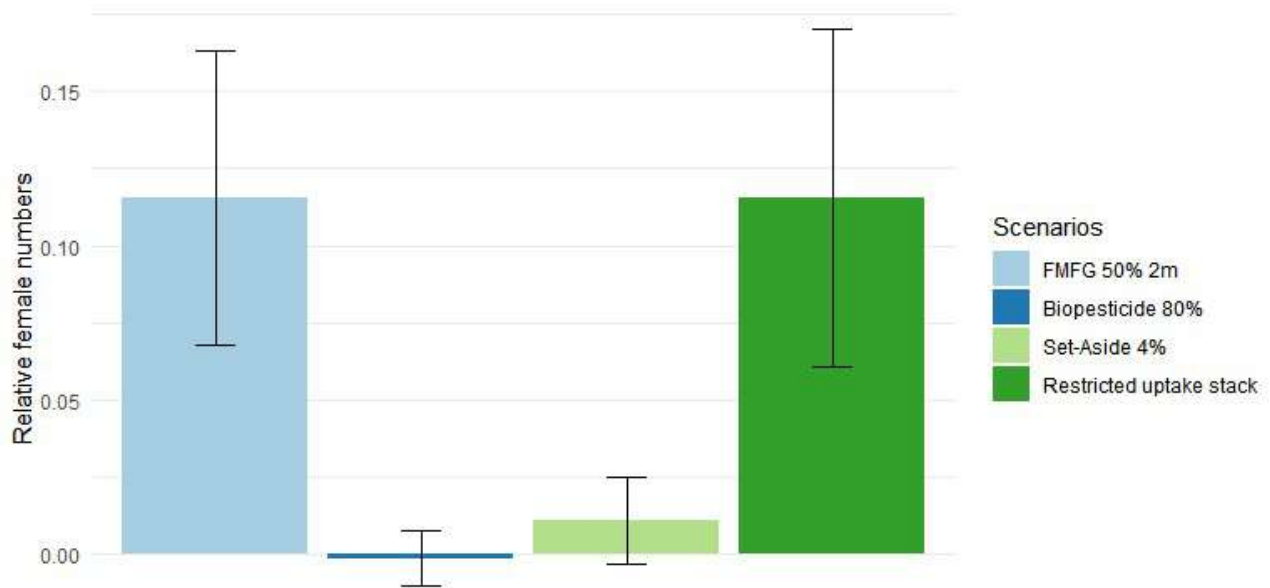


Figure 13.4 *Osmia* restricted uptake stacking scenarios chart showing relative numbers of female *Osmia* in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.2 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	12%	5%
Biopesticide 80%	-0%	1%
Set-Aside 4%	1%	1%
Restricted uptake stack	12%	5%

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13.2 Bembidion

13.2.1 Maximum uptake scenario

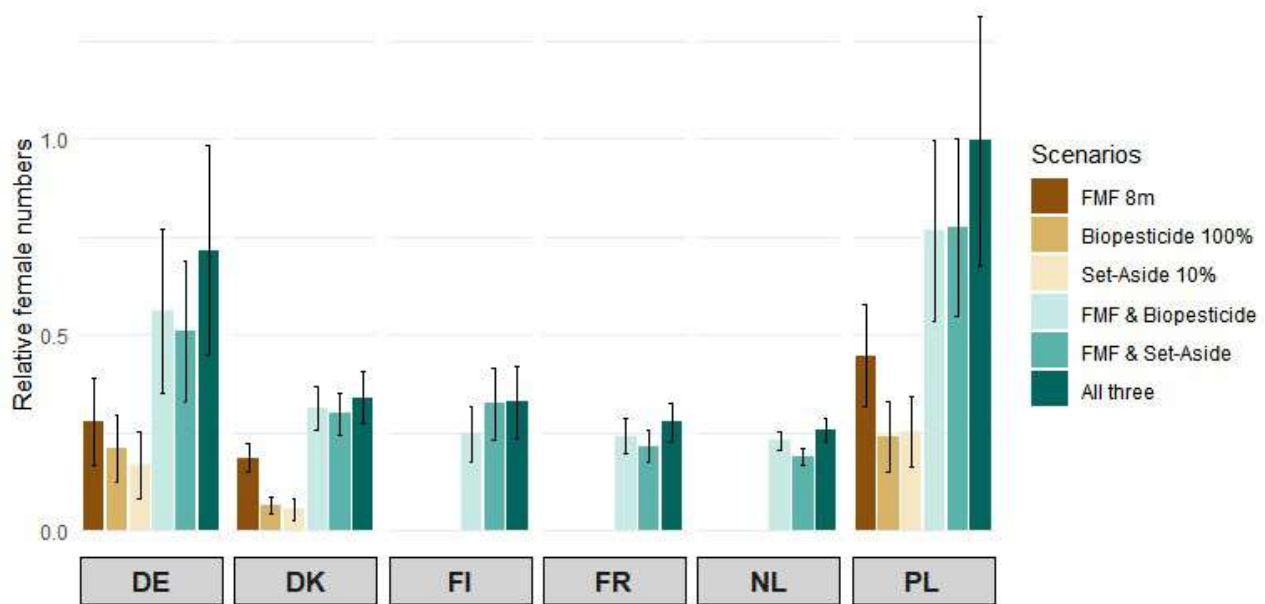


Figure 13.5 Bembidion maximum uptake stacking scenarios chart showing relative numbers of female in each scenario compared to the baseline in each country.

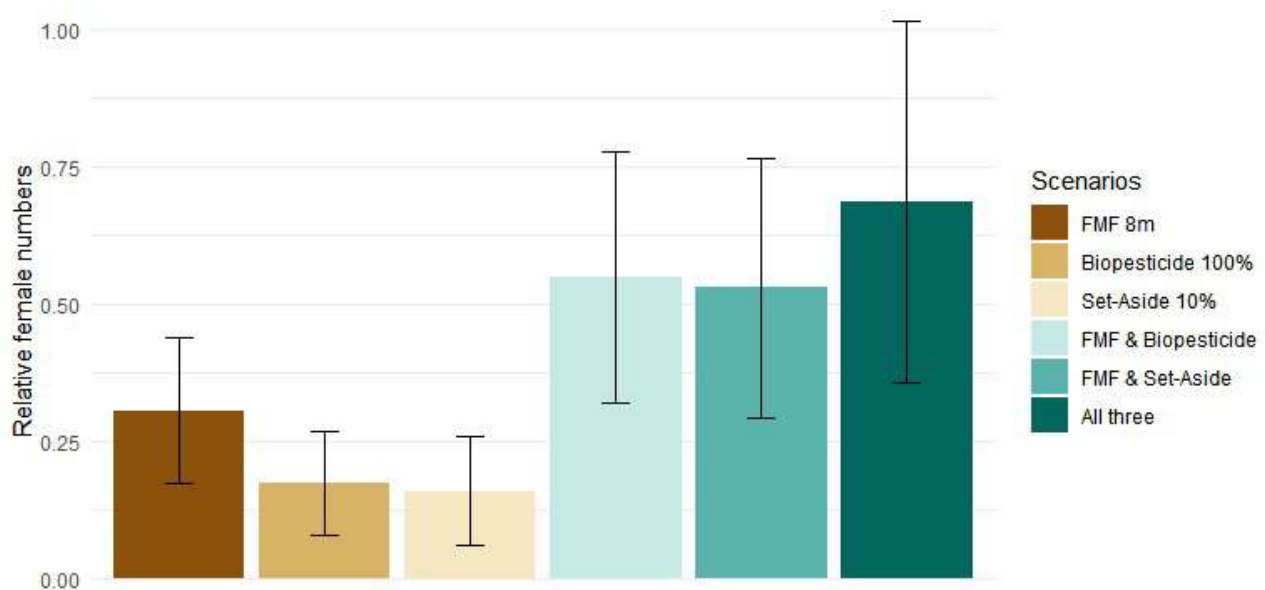


Figure 13.6 Bembidion maximum uptake stacking scenarios chart showing relative numbers of Bembidion in each scenario compared to the baseline combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.3 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios.

Scenarios	Relative change	Standard deviation
FMF 8m	30%	13%
Biopesticide 100%	17%	9%
Set-Aside 10%	16%	10%
FMF & Biopesticide	55%	23%
FMF & Set-Aside	53%	24%
All three	68%	33%

13.2.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

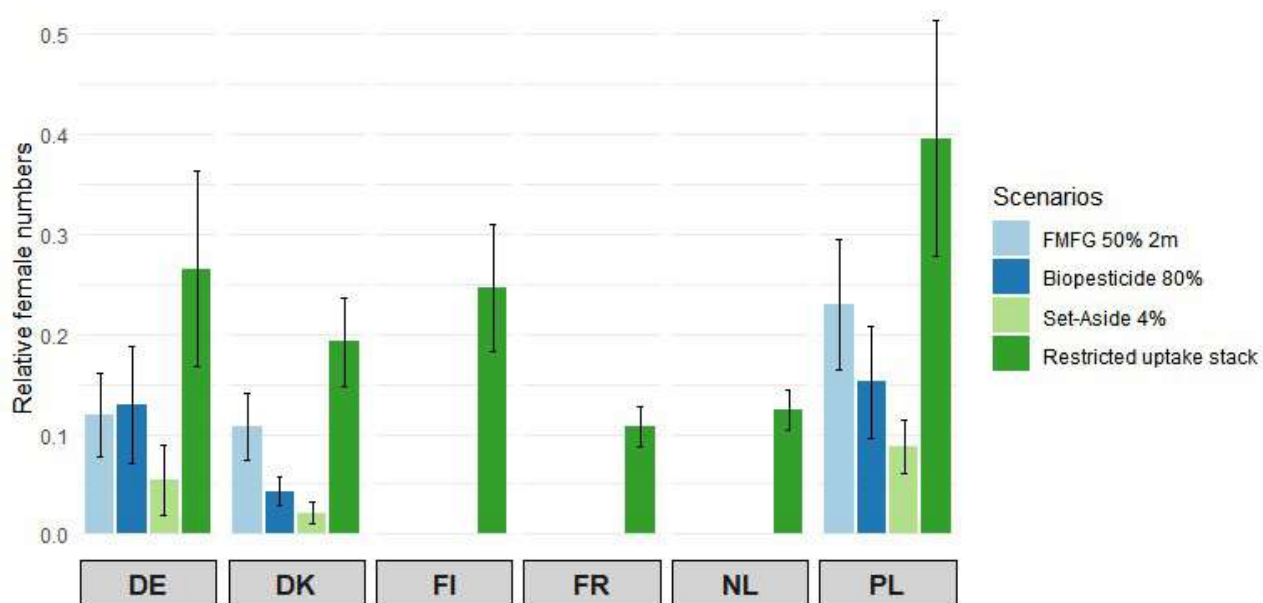


Figure 13.7 Bembidion restricted uptake stacking scenario and component scenarios showing relative numbers of Bembidion in each scenario compared to the baseline in each country. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

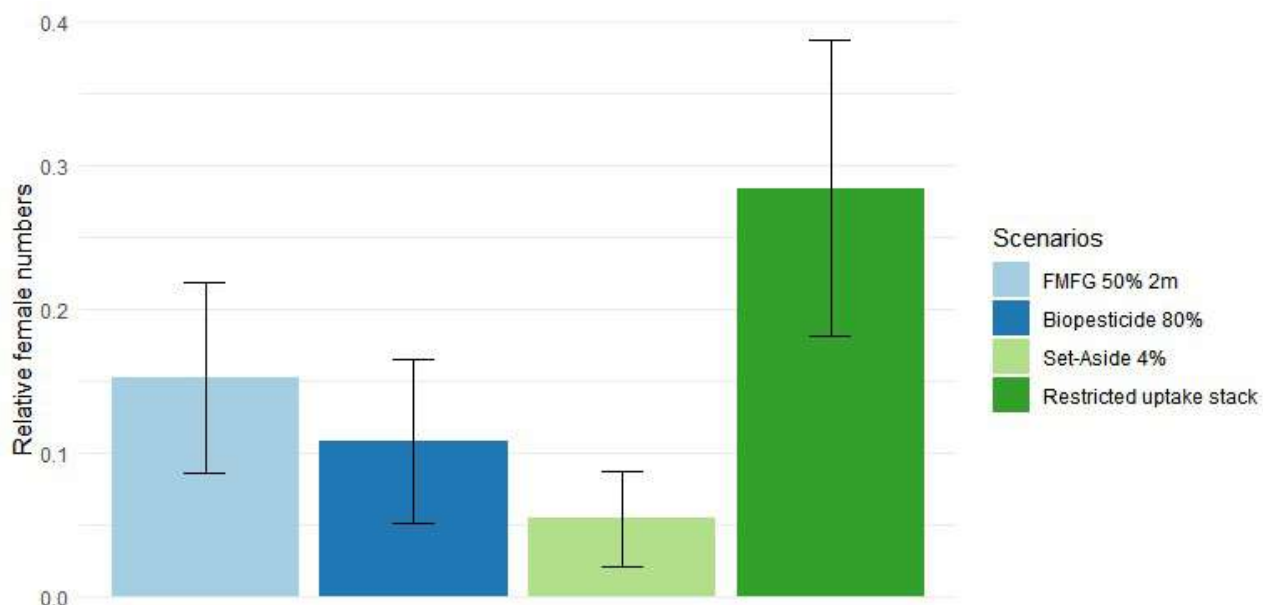


Figure 13.8 *Bembidion* restricted uptake stacking scenarios chart showing relative numbers of *Bembidion* in each scenario compared to the baseline combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.4 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	15%	7%
Biopesticide 80%	11%	6%
Set-Aside 4%	5%	3%
Restricted uptake stack	28%	10%

13.3 Oedothorax

13.3.1 Maximum uptake scenario

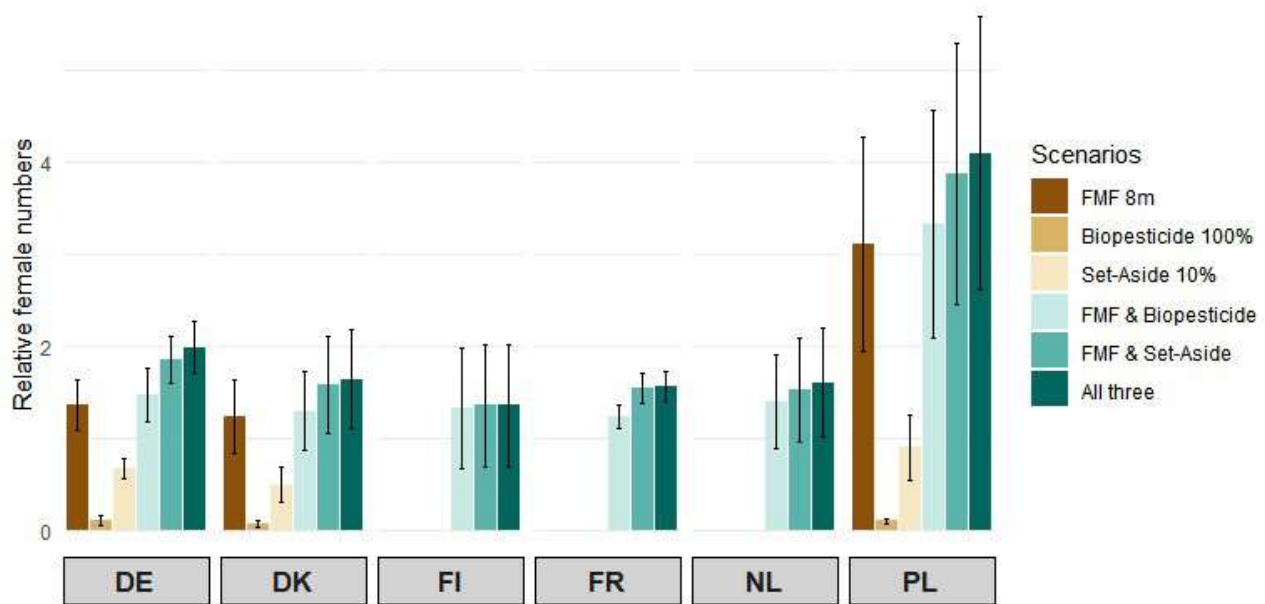


Figure 13.9 Oedothorax maximum uptake stacking scenarios chart showing relative numbers of female Oedothorax in each scenario compared to the baseline in each country.

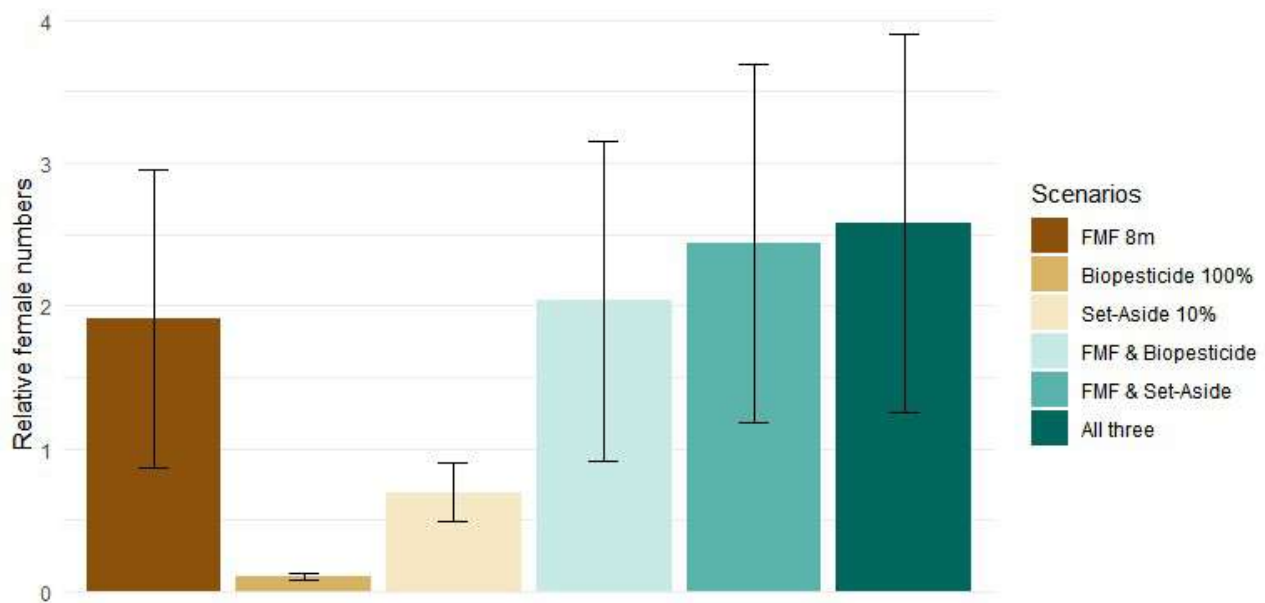


Figure 13.10 Oedothorax maximum uptake stacking scenarios chart showing relative numbers of female Oedothorax in each scenario compared to the baseline combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.5 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios.

Scenarios	Relative change	Standard deviation
FMF 8m	191%	104%
Biopesticide 100%	10%	2%
Set-Aside 10%	70%	20%
FMF & Biopesticide	204%	112%
FMF & Set-Aside	244%	125%
All three	258%	132%

13.3.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

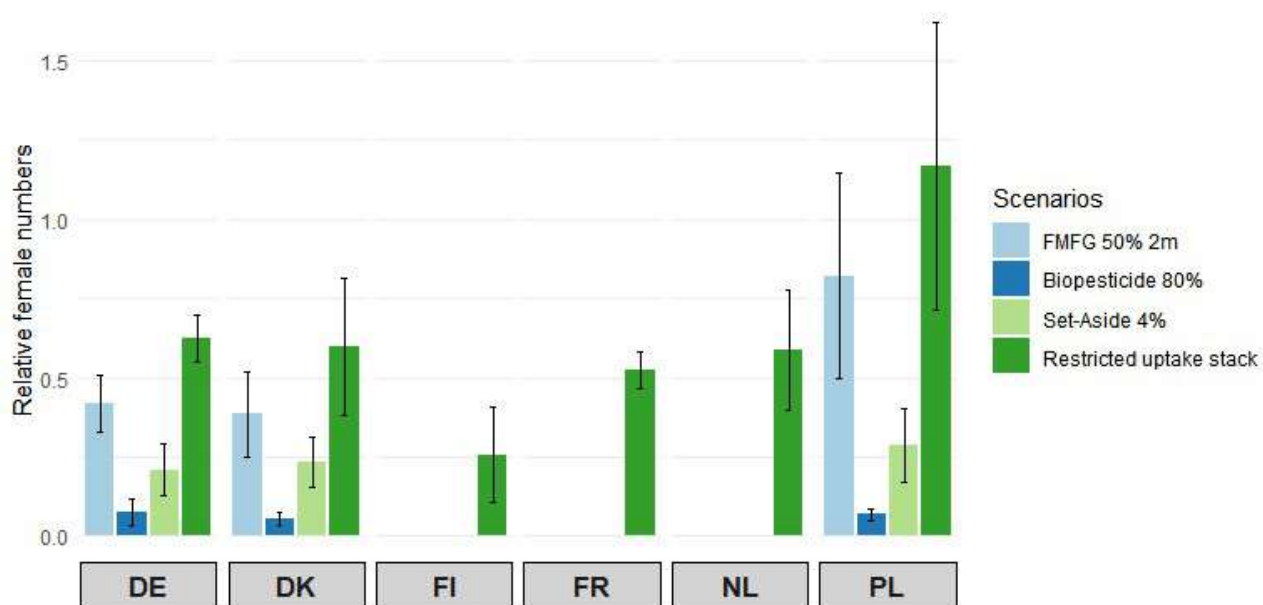


Figure 13.11 *Oedothorax* restricted uptake stacking scenario and component scenarios showing relative numbers of female *Oedothorax* in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

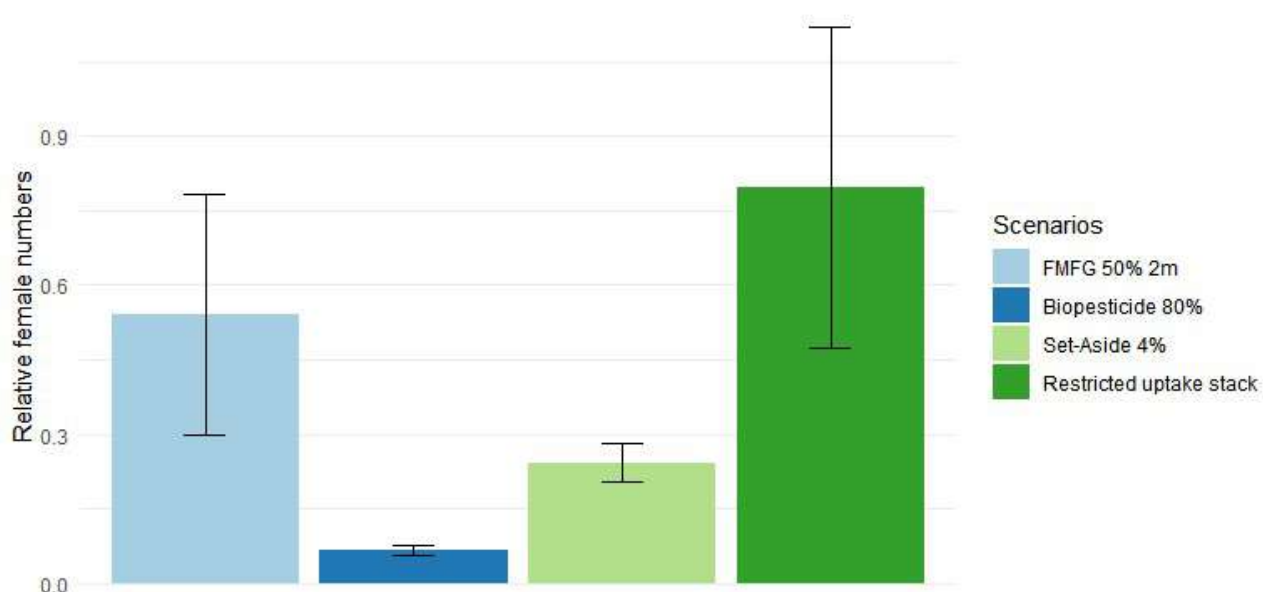


Figure 13.12 *Oedothorax* restricted uptake stacking scenarios chart showing relative numbers of female *Oedothorax* in each scenario compared to the baseline combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.6 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	54%	24%
Biopesticide 80%	7%	1%
Set-Aside 4%	24%	4%
Restricted uptake stack	80%	32%

13.4 Erigone

13.4.1 Maximum uptake scenario

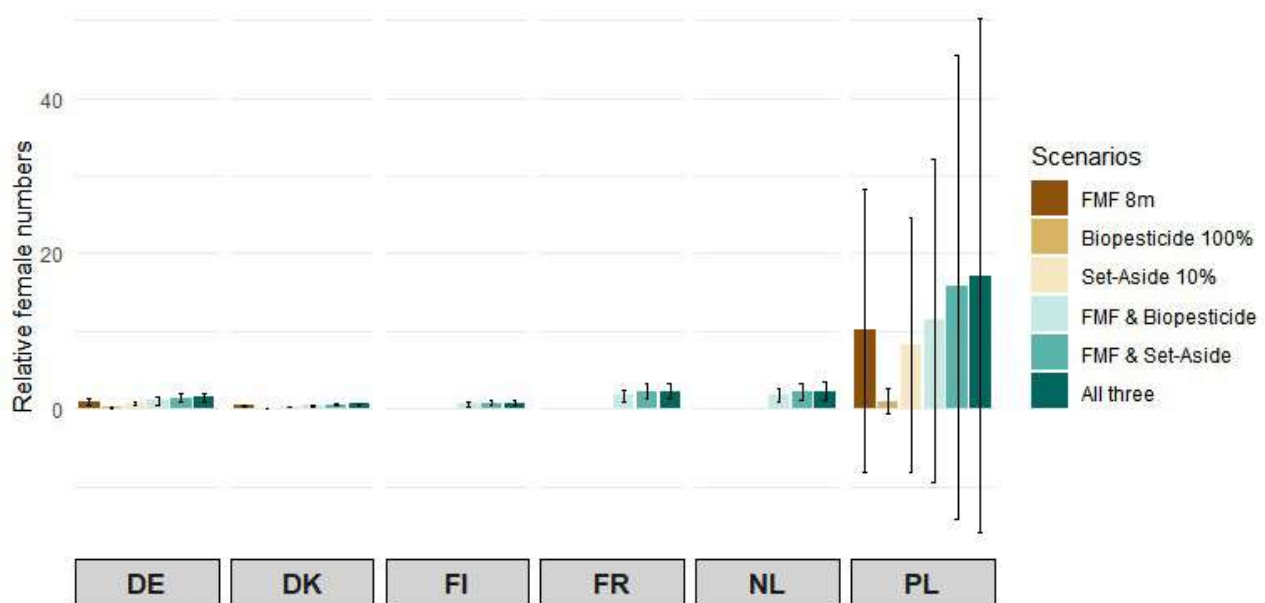


Figure 13.13 Erigone maximum uptake stacking scenarios chart showing relative numbers of female Erigone in each scenario compared to the baseline in each country.

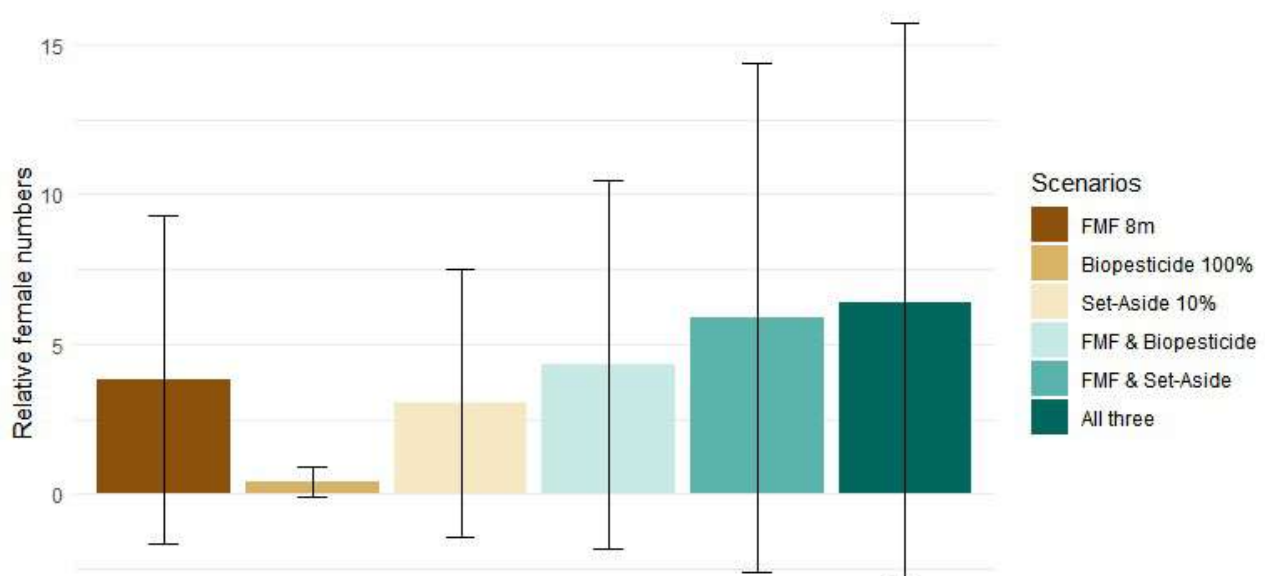


Figure 13.14 Erigone maximum uptake stacking scenarios chart showing relative numbers of female Erigone in each scenario compared to the baseline combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.7 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based on only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios.

Scenarios	Relative change	Standard deviation
FMF 8m	381%	546%
Biopesticide 100%	40%	50%
Set-Aside 10%	304%	448%
FMF & Biopesticide	430%	615%
FMF & Set-Aside	589%	851%
All three	641%	929%

13.4.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

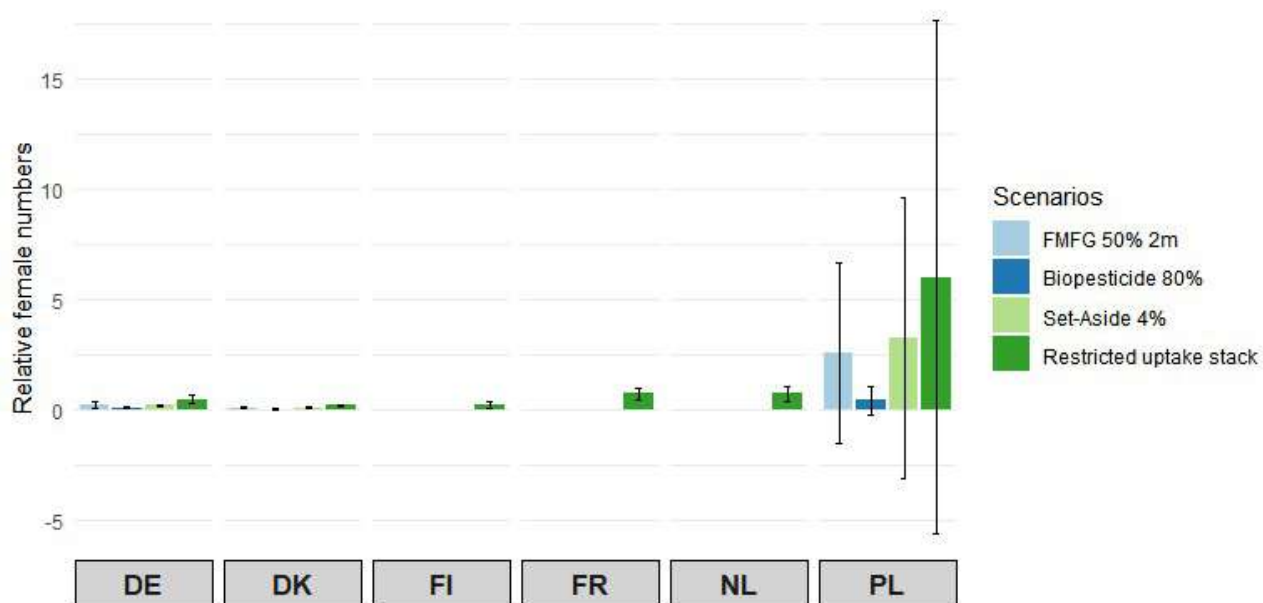


Figure 13.15 Erigone restricted uptake stacking scenario and component scenarios showing relative numbers of female Erigone in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

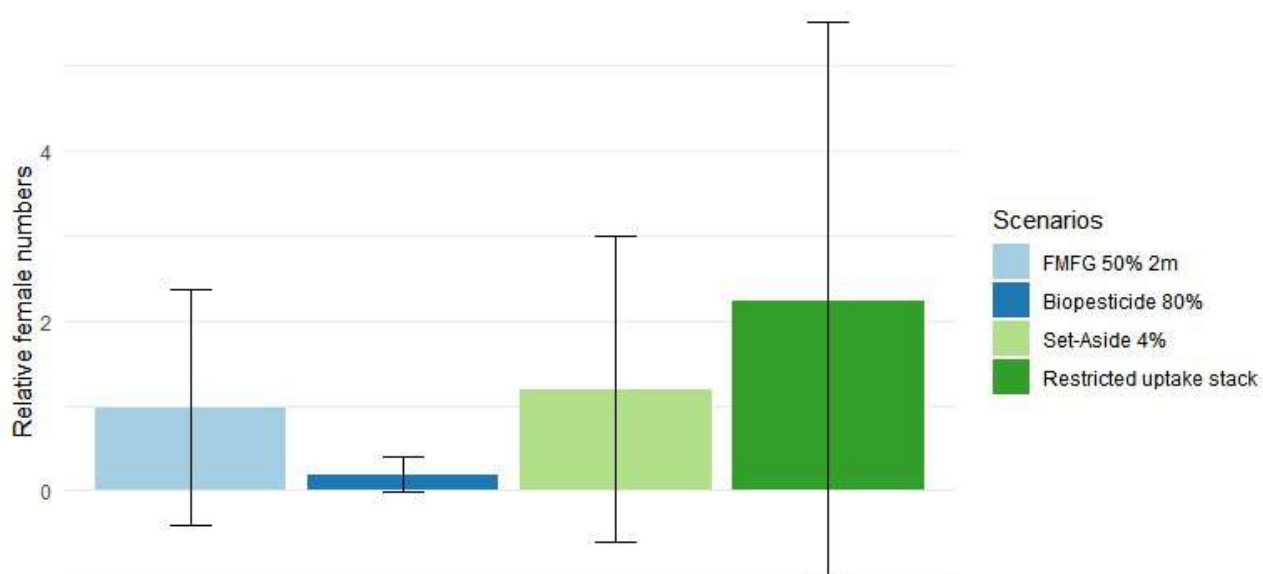


Figure 13.16 *Erigone* restricted uptake stacking scenarios chart showing relative numbers of female *Erigone* in each scenario compared to the baseline combining countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.8 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany, Denmark and Poland were combined as these were the only ones with individual scenarios. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	98%	138%
Biopesticide 80%	19%	21%
Set-Aside 4%	120%	179%
Restricted uptake stack	224%	327%

13.5 Ladybird

13.5.1 Maximum uptake scenario



Figure 13.17 Ladybird maximum uptake stacking scenarios chart showing relative numbers of Ladybird in each scenario compared to the baseline in each country.

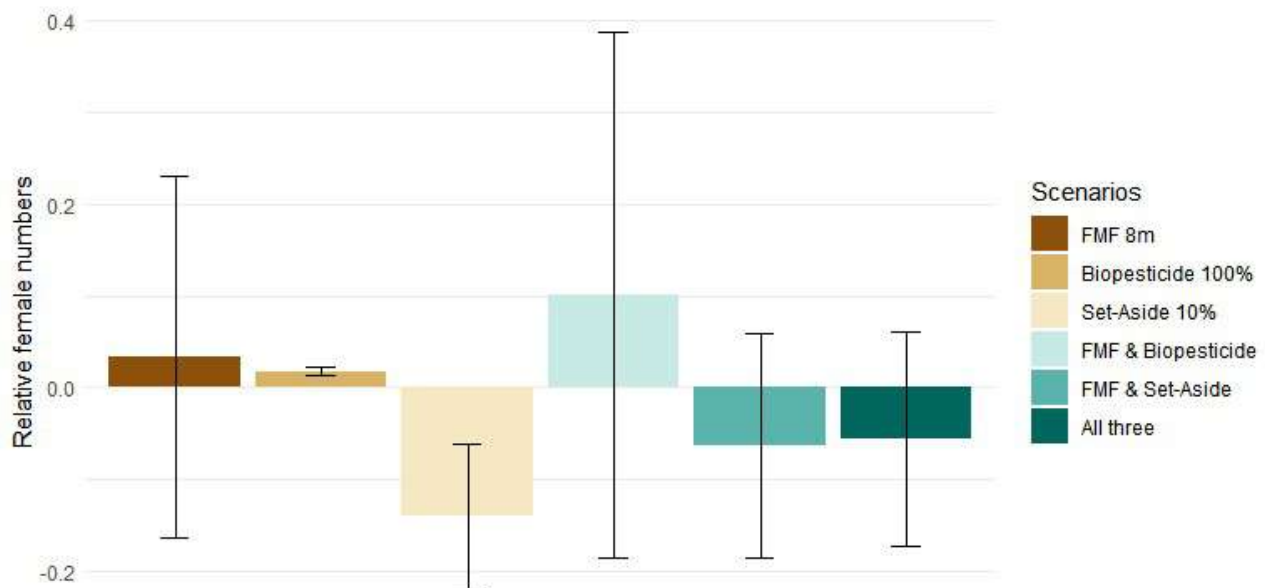


Figure 13.18 Ladybird maximum uptake stacking scenarios chart showing relative numbers of Ladybird in each scenario compared to the baseline combining countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.9 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios.

Scenarios	Relative change	Standard deviation
FMF 8m	3%	20%
Biopesticide 100%	2%	0%
Set-Aside 10%	-14%	8%
FMF & Biopesticide	10%	29%
FMF & Set-Aside	-6%	12%
All three	-6%	12%

13.5.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

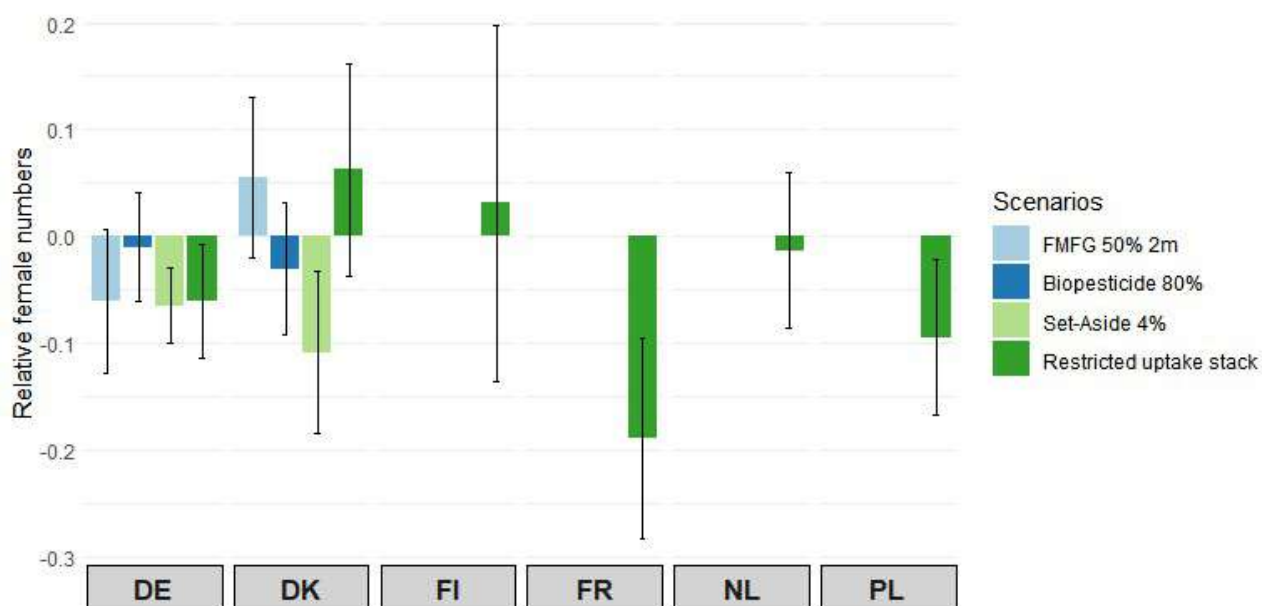


Figure 13.19 Ladybird restricted uptake stacking scenario and component scenarios showing relative numbers of Ladybird in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

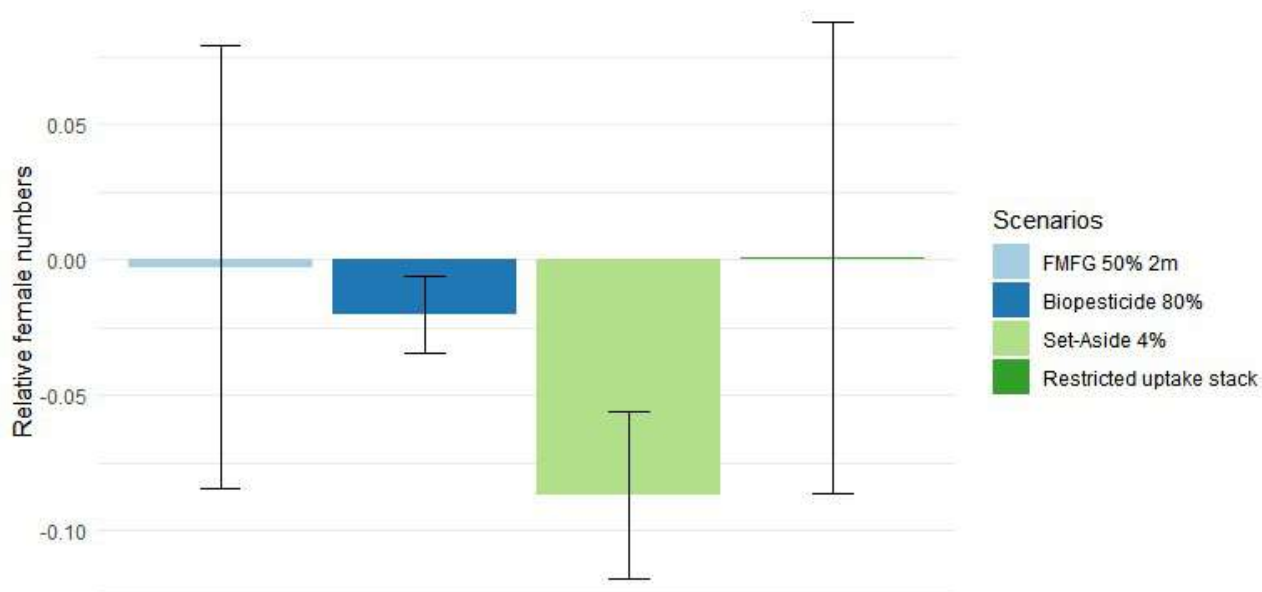


Figure 13.20 Ladybird restricted uptake stacking scenarios chart showing relative numbers of Ladybird in each scenario compared to the baseline combining countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.10 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	-0%	8%
Biopesticide 80%	-2%	1%
Set-Aside 4%	-9%	3%
Restricted uptake stack	0%	9%

13.6 Aphids

13.6.1 Maximum uptake scenario

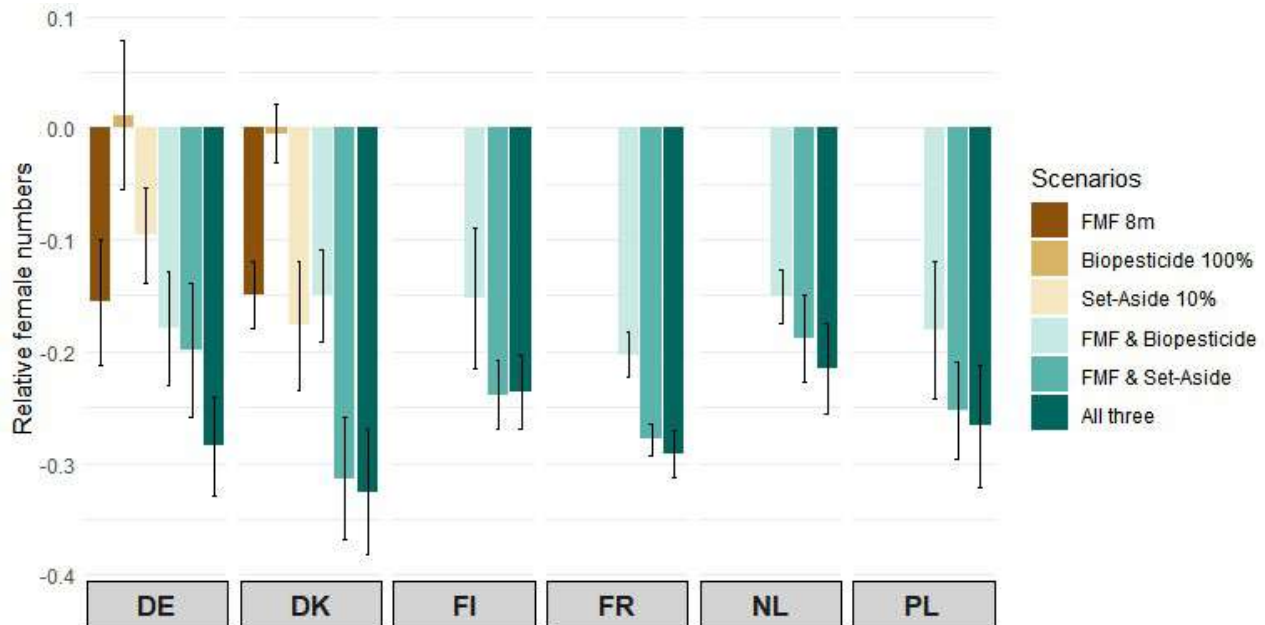


Figure 13.21 Aphids maximum uptake stacking scenarios chart showing relative numbers of Aphids in each scenario compared to the baseline in each country.

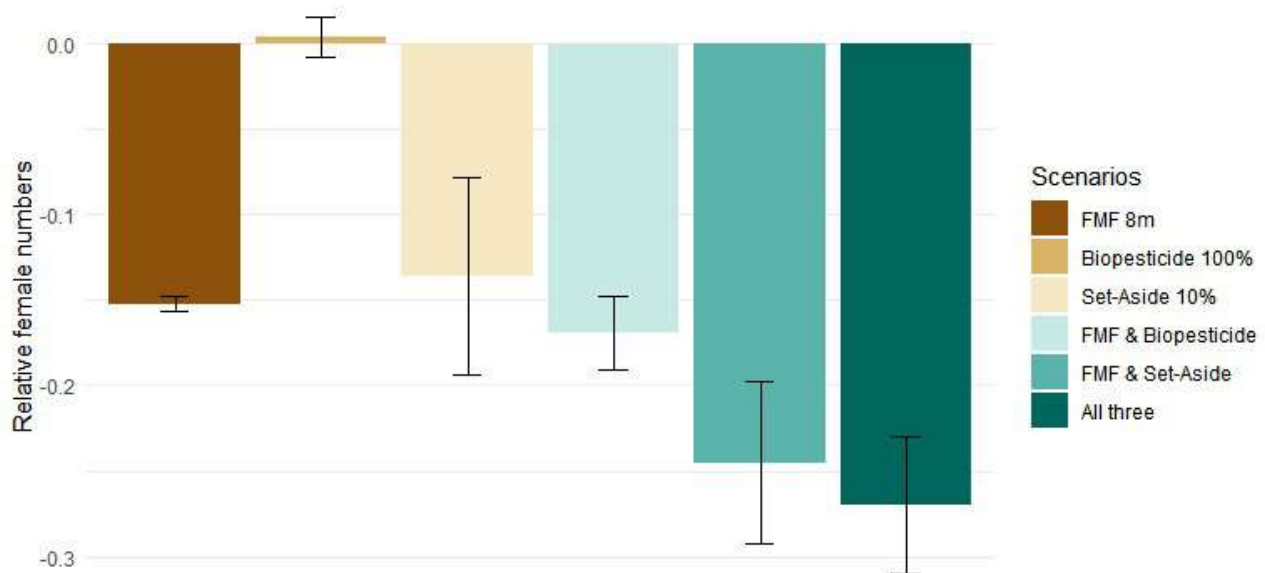


Figure 13.22 Aphids maximum uptake stacking scenarios chart showing relative numbers of Aphids in each scenario compared to the baseline combining countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.11 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios.

Scenarios	Relative change	Standard deviation
FMF 8m	-15%	0%
Biopesticide 100%	0%	1%
Set-Aside 10%	-14%	6%
FMF & Biopesticide	-17%	2%
FMF & Set-Aside	-25%	5%
All three	-27%	4%

13.6.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

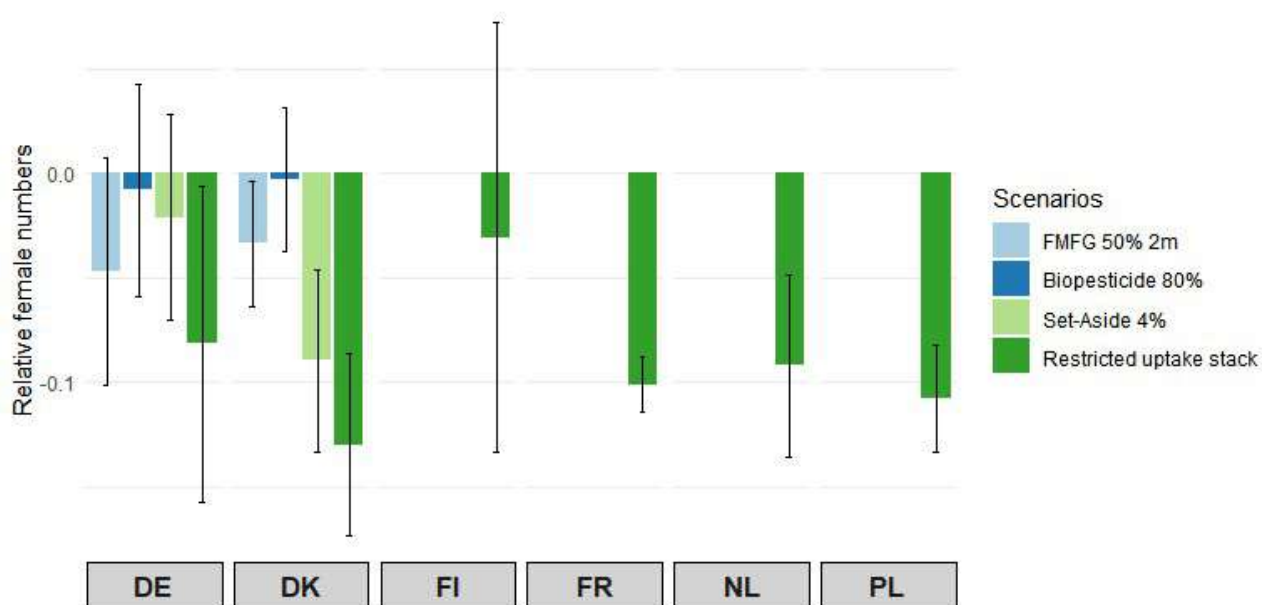


Figure 13.23 Aphids restricted uptake stacking scenario and component scenarios showing relative numbers of Aphids in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

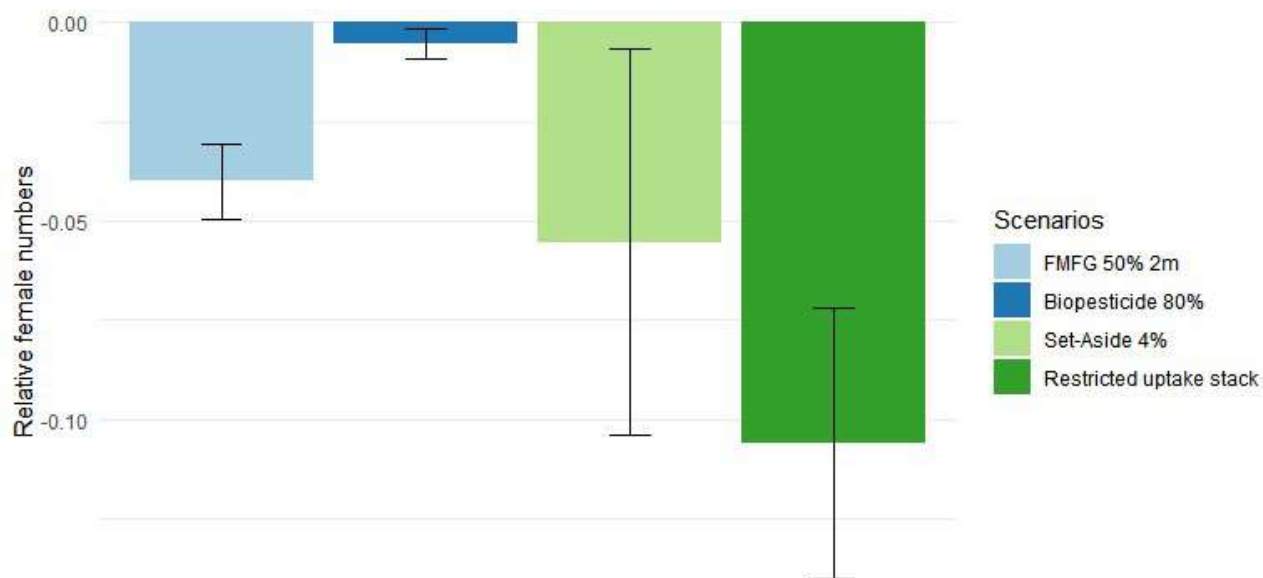


Figure 13.24 Aphids restricted uptake stacking scenarios chart showing relative numbers of Aphids in each scenario compared to the baseline combining countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.12 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Only Germany and Denmark were combined as these were the only ones with individual scenarios. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	-4%	1%
Biopesticide 80%	-1%	0%
Set-Aside 4%	-6%	5%
Restricted uptake stack	-11%	3%

13.7 Hare

13.7.1 Maximum uptake scenario

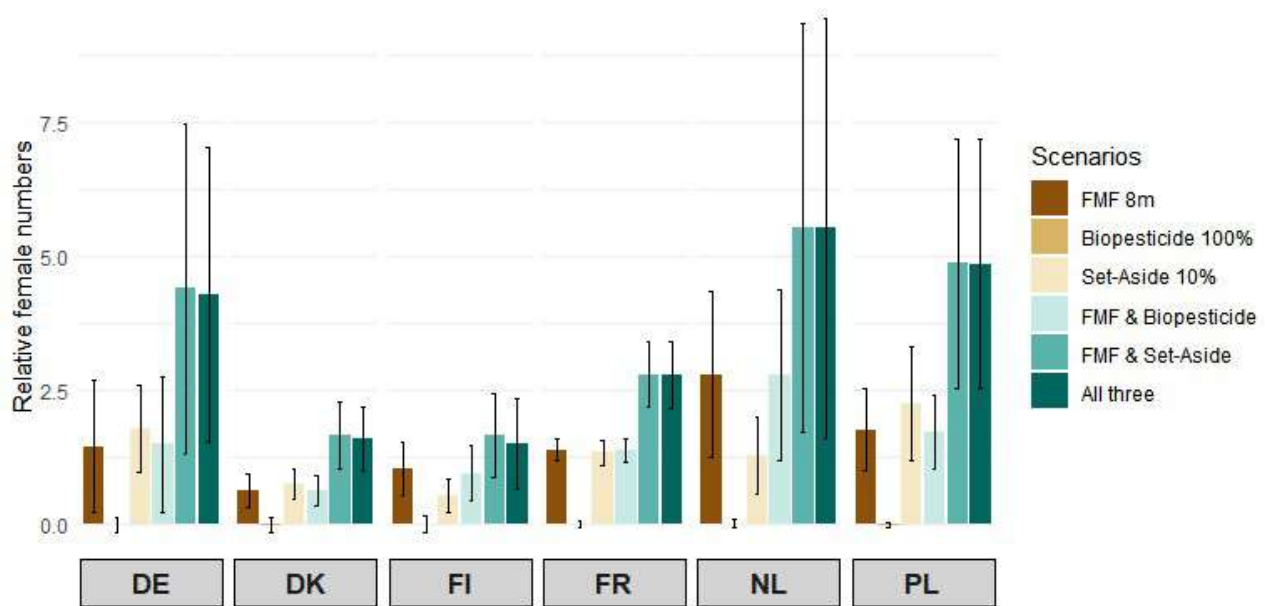


Figure 13.25 Hare maximum uptake stacking scenarios chart showing relative numbers of female Hare in each scenario compared to the baseline in each country.

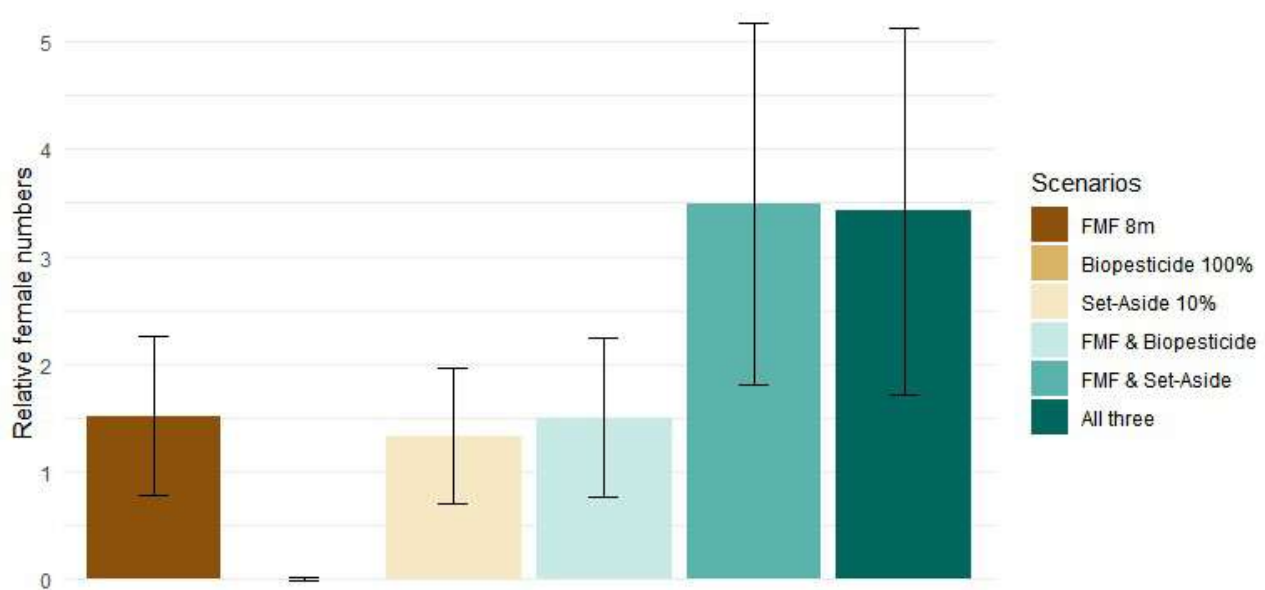


Figure 13.26 Hare maximum uptake stacking scenarios chart showing relative numbers of female Hare in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.13 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMF 8m	151%	74%
Biopesticide 100%	0%	1%
Set-Aside 10%	133%	63%
FMF & Biopesticide	150%	74%
FMF & Set-Aside	349%	168%
All three	342%	171%

13.7.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

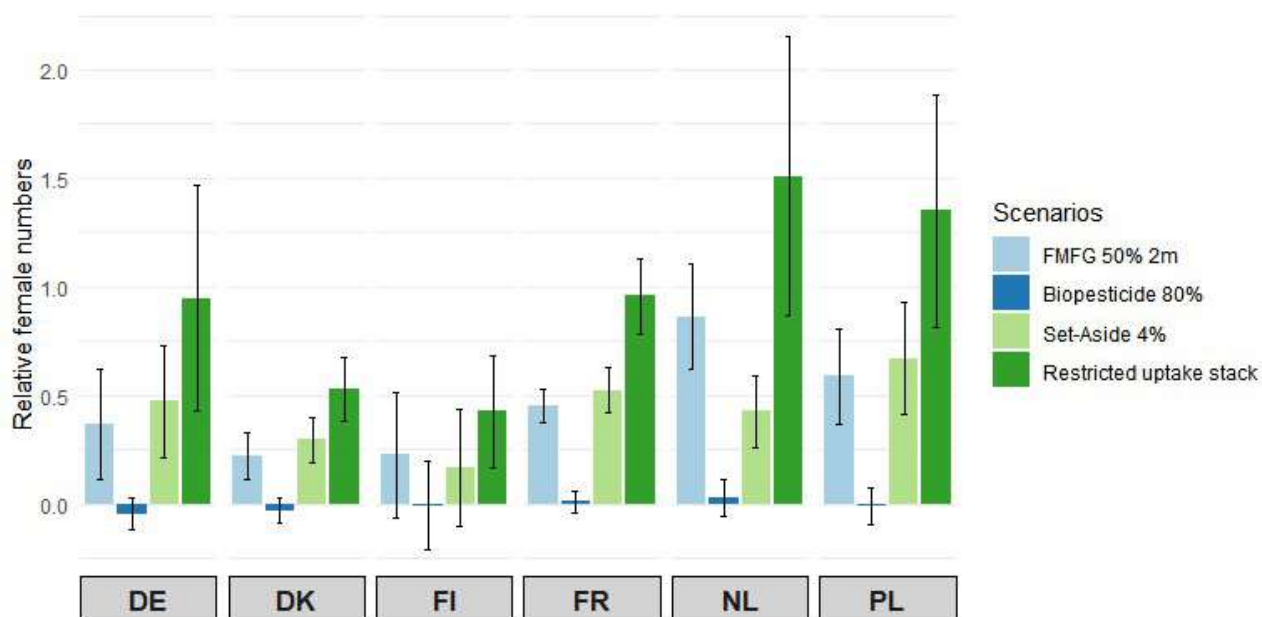


Figure 13.27 Hare restricted uptake stacking scenario and component scenarios showing relative numbers of female Hare in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

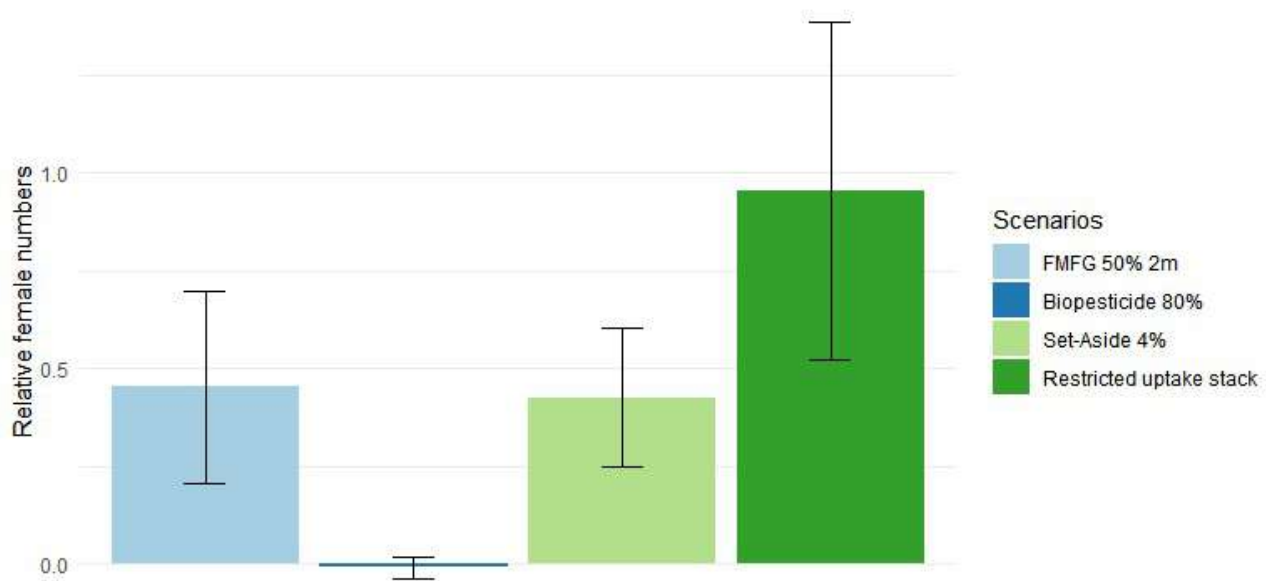


Figure 13.28 Hare restricted uptake stacking scenarios chart showing relative numbers of female Hare in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.14 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	45%	24%
Biopesticide 80%	-1%	3%
Set-Aside 4%	43%	18%
Restricted uptake stack	95%	43%

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13.8 Skylark

13.8.1 Maximum uptake scenario

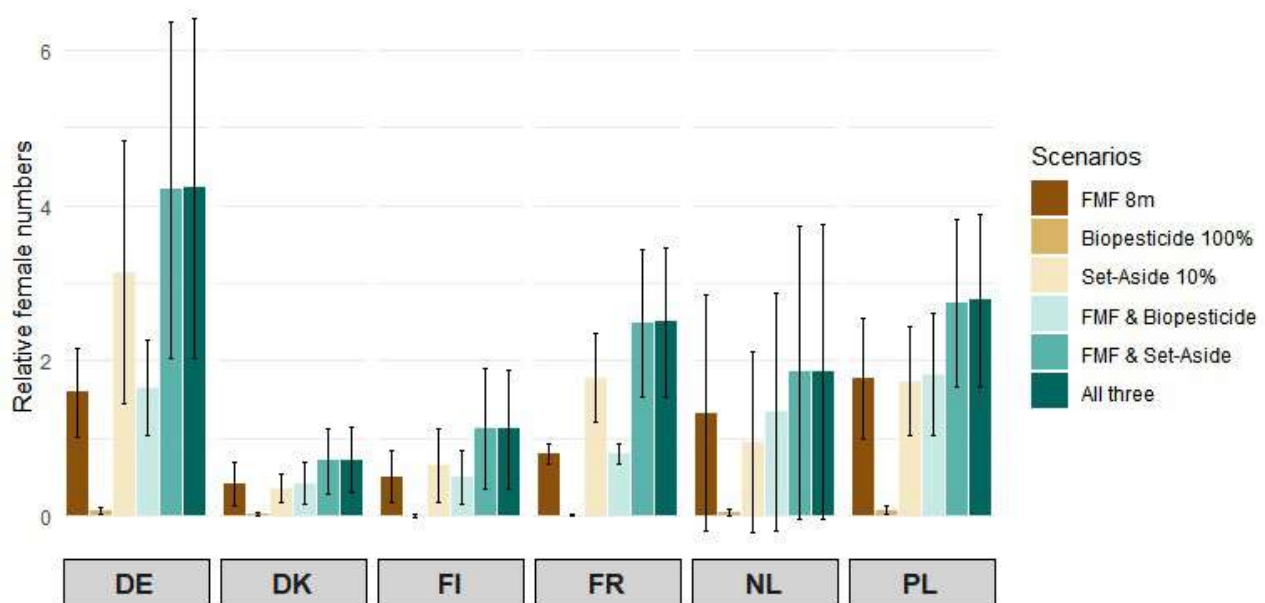


Figure 13.29 Skylark maximum uptake stacking scenarios chart showing relative numbers of female Skylark in each scenario compared to the baseline in each country.

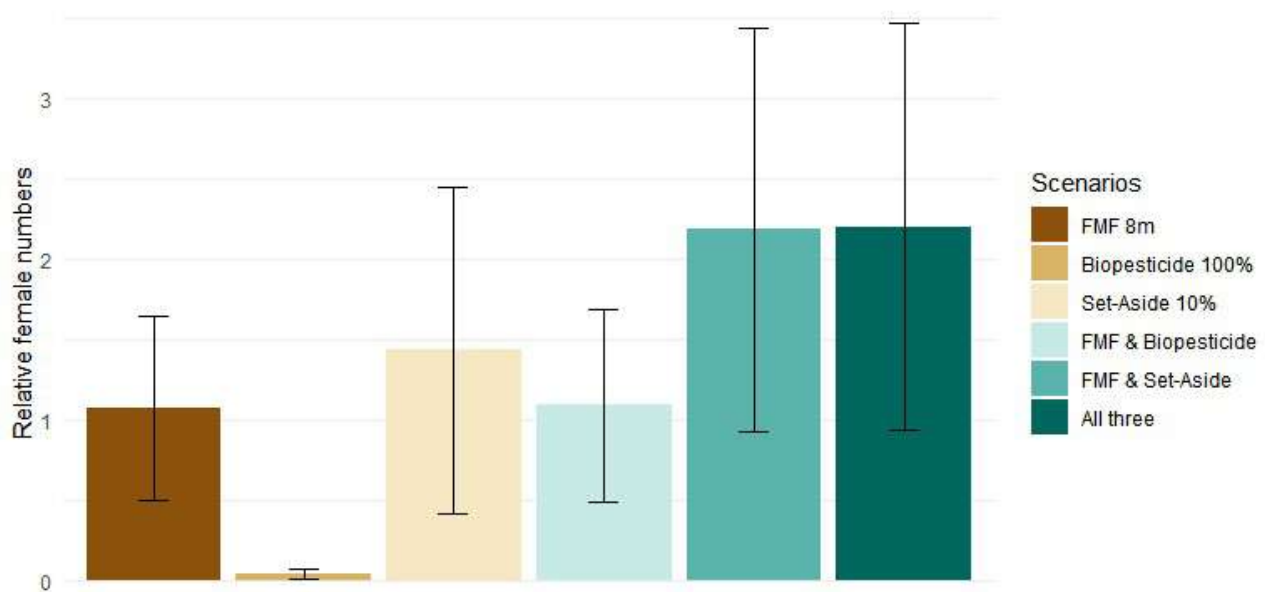


Figure 13.30 Skylark maximum uptake stacking scenarios chart showing relative numbers of female Skylark in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.15 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMF 8m	107%	57%
Biopesticide 100%	4%	3%
Set-Aside 10%	143%	101%
FMF & Biopesticide	109%	60%
FMF & Set-Aside	218%	125%
All three	220%	126%

13.8.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.

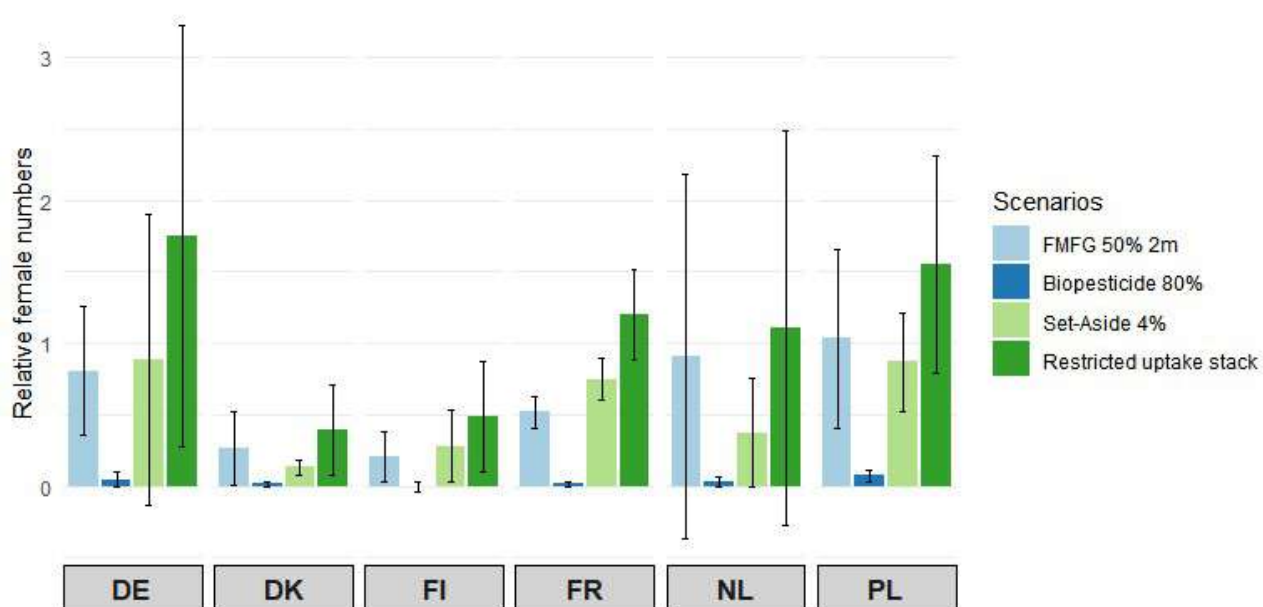


Figure 13.31 Skylark restricted uptake stacking scenario and component scenarios showing relative numbers of female Skylark in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

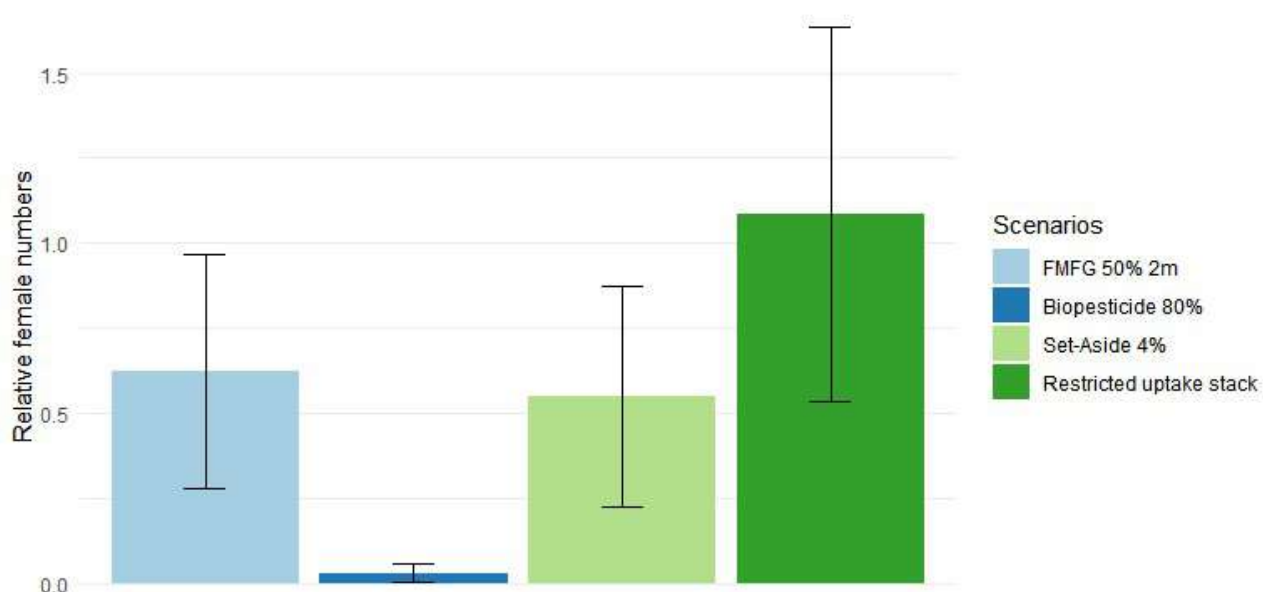


Figure 13.32 Skylark restricted uptake stacking scenarios chart showing relative numbers of female Skylark in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.16 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	62%	34%
Biopesticide 80%	3%	3%
Set-Aside 4%	55%	33%
Restricted uptake stack	108%	55%

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13.9 Vole

13.9.1 Maximum uptake scenario

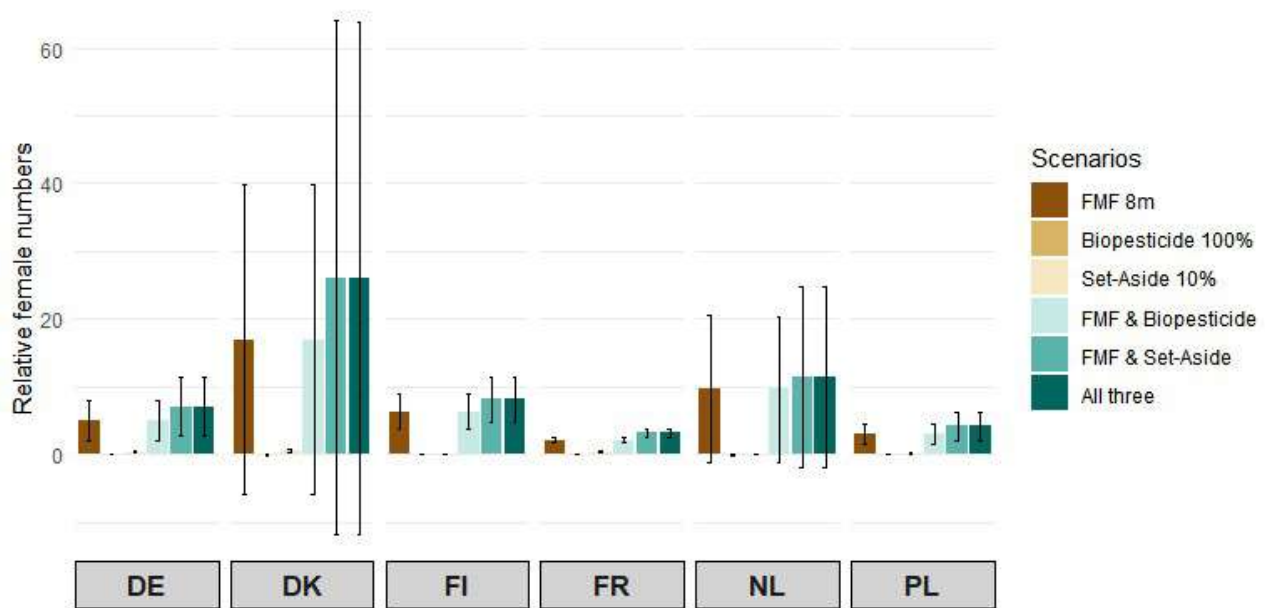


Figure 13.33 Vole maximum uptake stacking scenarios chart showing relative numbers of female Vole in each scenario compared to the baseline in each country.

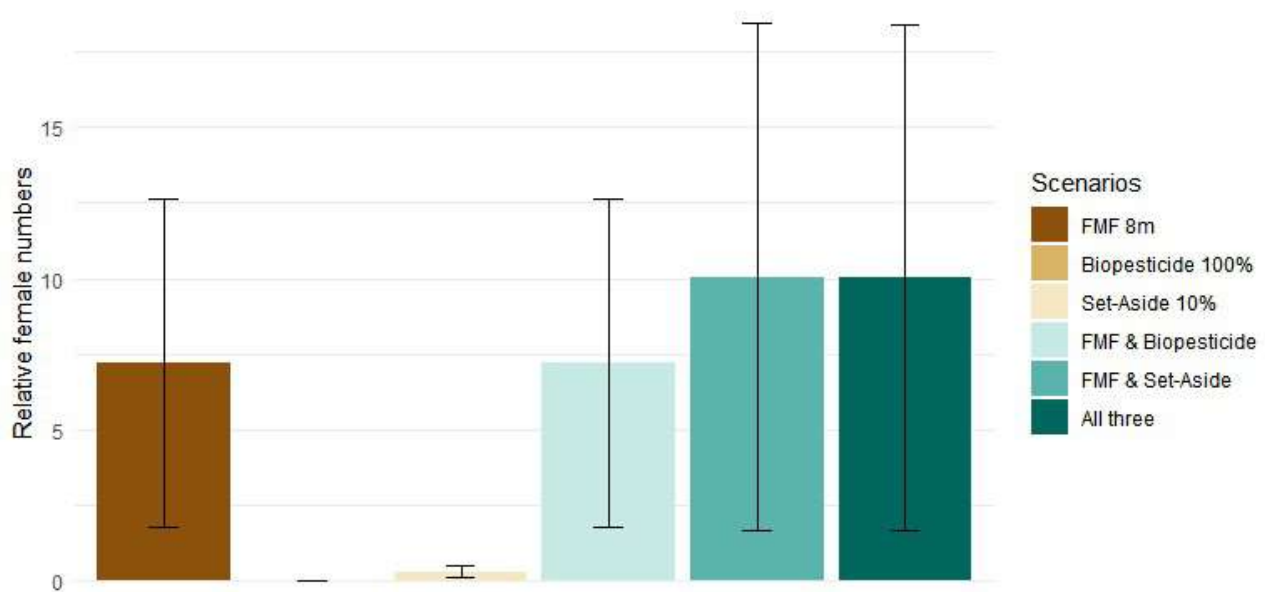


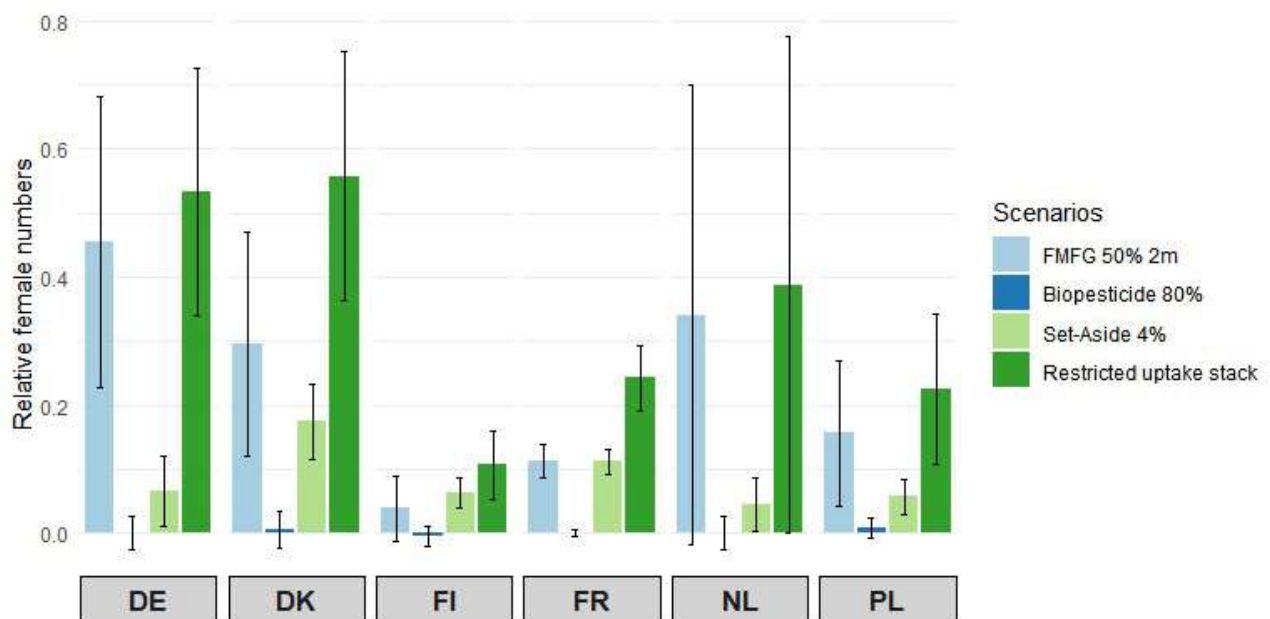
Figure 13.34 Vole maximum uptake stacking scenarios chart showing relative numbers of female Vole in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.17 Single and stacking scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMF 8m	721%	544%
Biopesticide 100%	1%	0%
Set-Aside 10%	29%	19%
FMF & Biopesticide	721%	545%
FMF & Set-Aside	1005%	838%
All three	1005%	836%

13.9.2 Restricted uptake scenario

We combined a field margin of 2m with a 50:50 mix of grass and flowers with 4% set-aside and biopesticides with 50% less lethal effect. We did not change the percentage of farmers that adopted these measures, and therefore it is still not realistic, only more likely to be adopted than the maximum uptake stacking scenarios.



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Figure 13.35 Vole restricted uptake stacking scenario and component scenarios showing relative numbers of female Vole in each scenario compared to the baseline in each country. The stacking scenario included 50% biopesticide, not 80% as shown. As 50% was considered more realistic, but we did not have reference values for this scenario, we show here 80% for reference.

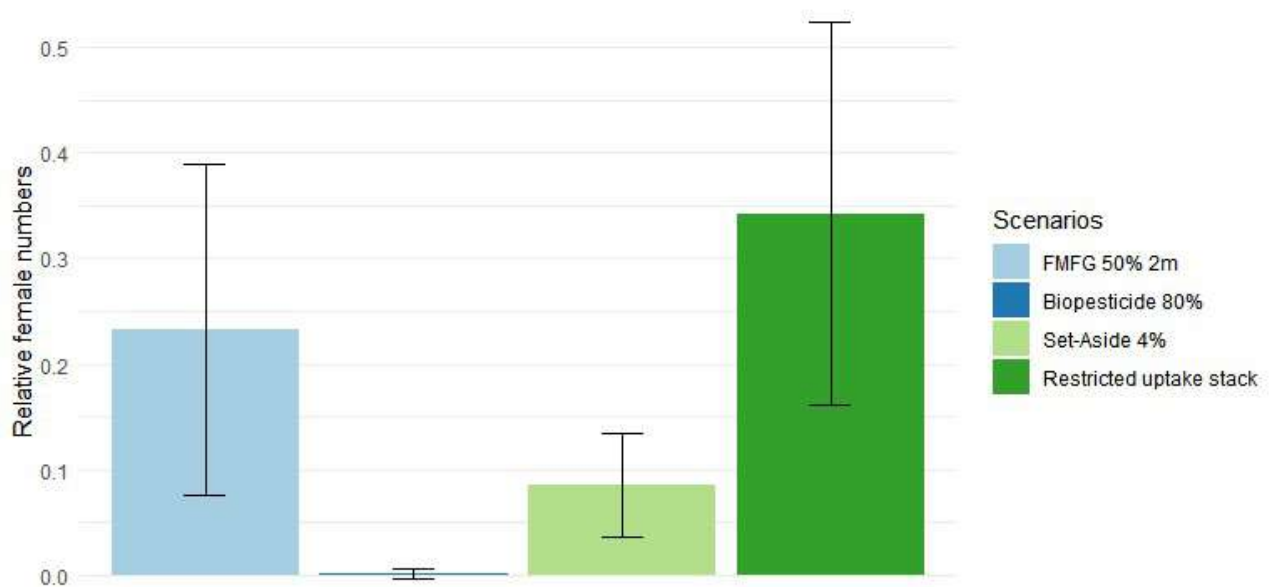


Figure 13.36 Vole restricted uptake stacking scenarios chart showing relative numbers of female Vole in each scenario compared to the baseline combining countries. Error bars derived from combining the standard deviation of the repetitions of simulation runs and landscapes for the scenario and baseline using the MOVER-R method (Donner and Zou, 2012).

Table 13.18 Single and restricted uptake stack scenarios compared to baselines. The standard deviation is the deviation between the means of the countries. Biocide 50% was used in the stacking scenario, not 80%, so this should be considered when comparing single and stacked scenarios. Note that this is based on all countries.

Scenarios	Relative change	Standard deviation
FMFG 50% 2m	23%	16%
Biopesticide 80%	0%	0%
Set-Aside 4%	9%	5%
Restricted uptake stack	34%	18%

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13.10 All species summary

Table 13.19 Comparison of the component scenarios, summed component scenarios and stacked scenarios. In the restricted uptake stacking scenario, Biopesticide 50% was used and not 80%. 50% was not run on its own, and therefore the 80% is given for context, but not included in a sum. The mean at the bottom, does not include ladybird and the aphid value is multiplied by -1. Excluding ladybird and changing the sign of aphids aligns the goal of reducing aphids with increasing other species. All values are given in percentages compared to baseline. This is based on results from Denmark and Germany.

Species	FMF 8m	Biopesticide 100%	Set-Aside 10%	FMF + Biopesticide	FMF + Set-Aside	FMF + Biopesticide + Set-Aside	FMF & Biopesticide	FMF & Set-Aside	All three	FMFG 50% 2m	Biopesticide 80%	Set-Aside 4%	FMFG 50% 2m + Set-Aside 4%	Restricted uptake stack
Osmia	11	1	1	12	11	12	10	11	10	10	0	1	11	10
Bembidion	23	14	11	37	35	48	44	41	53	11	9	4	15	23
Oedothorax	130	10	59	140	189	199	139	172	182	40	7	22	62	61
Erigone	66	11	46	77	112	123	75	99	105	18	8	16	35	35
Ladybird	3	2	-14	5	-11	-9	10	-6	-6	0	-2	-9	-9	0
Aphids	-15	0	-14	-15	-29	-29	-16	-26	-31	-4	-1	-6	-10	-11
Vole	1101	1	49	1102	1150	1150	1102	1658	1656	37	0	12	49	55
Hare	105	-1	128	104	233	232	107	304	294	29	-4	38	68	74
Skylark	100	4	175	105	275	279	104	245	247	54	3	51	105	107
Mean	194	5	60	199	254	259	200	319	322	26	3	19	44	47

Table 13.20 The stacking scenarios averaged across all countries.

Species	FMF & Biopesticide	FMF & Set-Aside	All three	Restricted uptake stack
Osmia	15%	16%	16%	12%
Bembidion	39%	39%	49%	22%
Oedothorax	168%	196%	204%	63%
Erigone	284%	382%	410%	141%
Ladybird	-5%	-14%	-13%	-4%
Aphids	-17%	-25%	-27%	-9%
Vole	721%	1005%	1005%	34%
Hare	150%	349%	342%	95%
Skylark	109%	218%	220%	108%